Rocky Flats

Environmental Technology Site

3-PRO-112-RSP-02.01

Revision 1

RADIOLOGICAL INSTRUMENTATION

APPROVED BY _____ / TL Vaughn _____ / 7/28/98

Print Name Date

Responsible Organization Radiological Engineering Effective Date 08/24/98

CONCURRENCE BY THE FOLLOWING DISCIPLINES IS DOCUMENTED IN THE PROCEDURE HISTORY FILE

Radiological Safety Section Manager 371/374
Radiological Safety Section Manager 559/707
Radiological Safety Section Manager 776/777
Radiological Safety Section Manager 771/774
Radiological Safety Section Manager 779/886
Radiological Safety Section Manager EM&S/DYNCORP
Subject Technical Expert (Radiological Engineering)

USE CATEGORY 3

This document SHALL be at a known location for reference.

ISR Review Not Required

The following have been incorporated in this document

~~97-DMR-001215~~ 7-28-98 TAV
DCF # 1

Periodic review frequency. 4 years from the effective date

1/78

Page 1 of 1

DOCUMENT CHANGE FORM (DCF)

DCF # 02.01-1

① DCF Originator: D J Davidson (Print) (Sign) 1/24/03 (Date)

Organization: Radiological Programs

Phone/Pager/Location: 5772/212-5884/MV72

② (Authorizes processing of request.)
Responsible Manager: R. R. Weedon (Print) (Sign) 1/24/03 (Date)

Organization: Radiological Programs (SE&QP)

Phone/Pager/Location: 6813/212-3827/MV72

③ Assigned SME: Bob Morris (Print Name) Gordon Madison for 1/30/03

Organization: 707/776 Project

Phone/Pager/Location: 6468

④ Radiological Instrumentation
Document Title

3-PRO-112-RSP-02 01
Existing Document Number and Revision

New Document Number and Revision (if Applicable)

⑤ Type of Document

- ☐ Policy
- ☐ Mgt Directive
- ☐ Manual
- ☒ Procedure (indicate type)
  - ☐ Technical
  - ☐ Alarm
  - ☒ Administrative
  - ☐ Other
- ☐ Instruction
- ☐ Job Aid
- ☐ Other

If "Other" is checked, please specify type: _____

⑥ Type of Modification

- ☐ New
  - ☐ One Time Use Only
- ☐ Revision
- ☐ Change
  - ☒ Minor
  - ☒ Major
- ☐ Cancellation

Rob for 1/24/03

⑧ Proposed Modification	⑨ Justification
Page 4, paragraph 3, delete purpose of operator aids statement.	Operator aids no longer exist in this procedure
	Reviewing Organization Changes
	Review organizations updated to reflect current org structure.

External (Technical) Review:

⑩ Reviewing Organization	⑪ Signature or Name of Reviewer	⑫ Date	⑩ Reviewing Organization	⑪ Signature or Name of Reviewer	⑫ Date
Subject-Matter Expert	Robert Morris /S/ Gordon Madison	1/30/03	771 Closure Proj	Calvin Morgan /S/	1/29/03
RISS Project	Phyllis Thomas /S/	1/30/03	707/776 Closure Proj	Harry Smith /S/	1/29/03
Material Stewardship	Bev Grant /S/	1/29/03	SEQP	Becky Middleton /S/	1/28/03
371/374 Closure Prj	Calvin Morgan /S/	1/29/03			

⑬ Special Reviews (NOTE: Other Special Reviews may be required, See PRO-815-DM-01 for more information.)

ISR (Number or "Not Required"): Not Required

TI Alignment (signature or N/A): Rob for Becky Middleton 1/30/03 (Sign) (Date)

Reviewed for Classification (If Required, "N/A" if not)
By: ERIC SWANSON
Date: 1/30/03 (4 INEL)

⑭ Approval (Completed to approve changes and cancellations only. New documents and revisions are approved by signature on the document cover page.)

Approval Authority: R. Sexton (Print Name) (Sign) Effective Date: 1/30/03

PADC-1998-00361

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Page 1 of 1

DOCUMENT CHANGE FORM (DCF)

(7) DCF # 99-RMRS-DCF-237

(1) DCF Originator: W E Dick (Print) W E Dick (Sign) 7/6/99 (Date)
Organization: RMRS Rad Eng Sup Services
Phone/Pager/Location: 8407/2124407/T130B

(2) Responsible Manager: H B Estabrooks (Print) (Sign) 7/7/99 (Date)
Organization: Rad Eng Sup Services RMRS
Phone/Pager/Location: 3769/2126469/T130B

(3) Assigned SME: Elliott D Lesses (Print) (Sign) 7/6/99 (Date)
Phone/Pager/Location: 5726/2123231/T130B

(8) Prescreen/SES/USQD Number: n/a
Independent Safety Review: n/a

(4) Radiological Instrumentation
Document Title

3-PRO-112-RSP-02 01 Revision 1
Existing Document Number and Revision

N/A
New Document Number and Revision (if Applicable)

(5) Type of Document

☐ Policy ☐ Directive ☐ Manual ☐ Technical Standard
■ Procedure ☐ Instruction ☐ Job Aid ☐ Other

(6) Type of Modification

☐ New ○ One Time Use Only
☐ Revision
☐ Cancellation
■ Change ○ Editorial ○ Intent ● Non-Intent

(9) Effective Date: ~~7/19/99~~ 7/22/99 wad per HBE 7/22/99 Expiration Date: N/A

(10) Item	(11) Page	(12) Step	(13) Proposed Modification
1	2	LOEP	Modify list of effective pages (LOEP) to match attached affected pages
2	6	4 [2]	Add the following text to include the equation and representation of symbols used in the equation "The time that a survey should stop and wait until the probability of getting another count is at least 90% is calculated as follows t = 13,800 / CAE Where t = time period for static count(s) C = release criteria (dpm/100 cm^2), A= physical probe area (cm^2) and E = detector efficiency (4π)
3	4	Header	Change effective date to 8/24/98
4	6-7	All	Make format consistent on both pages
5	7	6	Change 3-127-RP-2001 and the word "Control" in the title to 3-PRO-212-RSP-18 01 and "Safety"

(10) Item	(14) Justification
1)	per Site Document Requirements Manual (SRDM)
2)	The change is necessary for determining a length of a static count once you detect by alpha scan and is based on MARSSIM technique
3)	Editorial correction
4)	Editorial correction
5)	Updated to reflect current nomenclature (title and designation)

(15) Reviewing Organization	(16) Name of Reviewer	(17) Date	(15) Reviewing Organization	(16) Name of Reviewer	(17) Date
RMRS RE		7/6/99			
RMRS RO	/S/ J. Carosso	7/9/99			
~~SSOC RS~~	per email dtd 7/22/99 wad				
KH-RP	/S/ W.C. Zuriske	7/21/99			

(18) Approval Authority: T L Vaughn (Print) (Sign) 7/22/99 (Date)

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LIST OF EFFECTIVE PAGES

Pages	Effective Date	Pages	Effective Date
1	08/24/98		
2	02/7/03		
3	08/24/98		
4	02/07/03		
5	08/24/98		
6-7	07/22/99		

Total Number pages 7 MS 2-5-03

The following DCFs are active for this procedure

99-RMRS-DCF-277

DCF-02 01-1

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TABLE OF CONTENTS

1. PURPOSE

This procedure contains the requirements of Title 10 Code of Federal Regulations Part 835 (10 CFR 835) and the Rocky Flats Environmental Technology Site Radiological Control Manual (Site RCM) regarding the use of radiological instrumentation

The Instrument Technical Specification Sheets are based on information compiled from instrument manufacturer technical data, Site RCM, technical basis documents, and/or test data.

DCF-02 01-1

RESPONSIBILITIES

2.1 Instrument User

Trained and qualified to operate radiological instrumentation in accordance with Site RCM Article 551 2

Performs monitoring with appropriate radiological instrumentation

Completes proper survey forms

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3. INSTRUCTIONS

Instrument User

[1] Ensure that the instrument being used meets the following

- Appropriate for the types, levels, and energies of the radiations encountered and the existing environmental conditions
- Within calibration
- Meets the performance test and operational check requirements in accordance with the Site RCM Article 562 9 and as stated on the Instrument Technical Specification Sheets

[2] Return instrument to the Instrument Repair and Calibration Facility if any of the following conditions exist

- Instrument is due for calibration
- Instrument is physically damaged
- Instrument fails performance test or operational check
- Instrument is malfunctioning or responding abnormally
- Instrument requires maintenance beyond what is specified on the Instrument Technical Specification Sheet

[3] Report to the Instrument Repair and Calibration Facility, any change in an instruments status, **in writing**, such as

- Instrument is disposed of, declared surplus or declared excess
- Instrument is lost or destroyed

4 MINIMUM DETECTABLE ACTIVITY AND DECISION LEVELS

Instrument User

[1] For contamination detection instruments, in a stationary mode (e g Eberline BC-4, SAC-4, NE Electra, etc) use the following equation to determine the minimum detectable concentration

$$MDC = \frac{2.71 + 3.29\sqrt{R_b\, t_g\left[1+\left(\frac{t_g}{t_b}\right)\right]}}{eff\ t_g\ K}$$

Where MDC - minimum detectable concentration
R_b - background count rate (cpm)
t_g - gross count time (minutes)
t_b - background count time (minutes)
eff - efficiency (counts/disintegration)
K - correction and conversion factors

[2] For contamination detection instruments, in a scanning mode (e g NE Electra, etc) use the following equation to determine the minimum detectable concentration

For Alpha Activity, using an instrument with a near-zero (BKG < 3 cpm) background count rate, the probability of observing a single count is determined by

$$P(n \geq 1) = 1 - e^{-\frac{GEd}{60V}}$$

Where $P(n \geq 1)$ = probability of observing a single count
G = contamination activity, release limit (dpm)
E = detector efficiency (4π)
d = width of detector in direction of scan (cm)
V = velocity, scanning speed (cm/s)

When a count is detected, then stationary measurements are performed, and the MDC in [1] above applies The time that a survey should stop and wait until the probability of getting another count is at least 90% is calculated as follows

$$t = \frac{13{,}800}{CAE}$$

Where t = time period for static count (s)
C = release criteria (dpm/100 cm^2)
A = physical probe area (cm^2)
E = detector efficiency (4π)

For Beta Activity $$\text{Beta Scan MDC} = \frac{\text{MDCR}}{\sqrt{E_{hf}}\ E\left(\frac{A}{100}\right) C}$$

Where MDCR = minimum detectable count rate (cpm)
E_{hf} = human factors efficiency (default value = 0 65)
E = efficiency
A = probe area
C = other conversion factors

The MDCR (cpm) is defined as $$\text{MDCR} = d' \sqrt{b_i}\ \left(\frac{60}{i}\right)$$

Where d' = detectability value, assumed to be 2 65 for a correct detection rate of 90% and a false positive probability of 10%
b_i = background count in counting interval i
i = count interval where the probe is near the source

[3] For dose rate instruments (e g Eberline RO-20, Victoreen 450B, Eberline ESP-1, etc) the Minimum Detectable Dose Rate (MDDR) is defined as 20% of the top end of lowest calibrated scale

5. DISPOSITION OF RECORDS

Maintain and disposition records in accordance with established requirements, procedures, and policies

6. REFERENCES

Title 10 Code of Federal Regulations Part 835, Occupational Radiation Protection
Rocky Flats Environmental Technology Site Radiological Control Manual
1-V41-RM-001, Records Management Guidance for Records Sources
3-PRO-212-RSP-18 01, Guidance for Management of Records in Radiological Safety
Multi-Agency Radiation Survey and Site Investigation Manual (MARSSIM), 12/97

LAST PAGE

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PORTABLE CONTAMINATION INSTRUMENT PERFORMANCE TEST LOG

RSFORMS-02.01-02

INST TYPE/SERIAL # ____________ CAL DUE DATE ____________ INSTRUMENT EFFICIENCY ____________ BLDG ____________

This form is used to record parameters noted during daily performance checks Instruments that require additional repair or service are returned to Instrumentation Repair Facility

TIME/DATE	RCT NAME EMP #	BATT STAT Yes No	COUNT TYPE Alpha/ Beta	BKG (cpm)	INSTRUMENT READING (Net cpm) X1 Range	X10 Range	X100 Range	X1K Range	PROBE S/N	% ERROR ± 20% IN TOL (Initials)	RCT SIGNATURE

Rev 02/01

* Guidance for use of this form is located on the back of the form

Note The width of the columns and the number of rows can be adjusted provided all of the information requested on the form is retained

PADC-1998-00381

SOURCE BOARD CERTIFICATION DUE DATE (Alpha/Beta) _____ SOURCE ISOTOPE (Alpha/Beta) _____

ALPHA SOURCE/ SOURCE BOARD

	S/N	Source (dpm)	Range (cpm) ± 20%
X1/CLS			
X10/CLS			
X100/CLS			
X1K/CLS			

BETA SOURCE/SOURCE BOARD

	S/N	Source (dpm)	Range (cpm)± 20%
X1/CLS			
X10/CLS			
X100/CLS			
X1K/CLS			

Approved by
RS Supervision

_____ / _____ / _____ / _____

Name (print) Signature Employee # Date

$$\%Error = \frac{(Net\ cpm + eff) - Source\ dpm}{Source\ dpm} \times (100)$$

Where Net cpm = Source cpm - Background cpm

GUIDANCE

- The appropriate instrument data and building location is recorded on RSFORMS-02 01-02
- Obtain an appropriate certified source or source block for the instrument being tested
- A general inspection is performed on the instrument for the following
  - Physical condition of the detector, cables, and instrument
  - Instrument battery/power supply check is satisfactory
  - Instrument audio check is satisfactory, as applicable
  - Instrument light leak check is satisfactory, as applicable
  - Instrument background response check is within tolerances of expected values
  - Instrument corrected source count reading (15 second average reading) falls within an acceptable range (± 20% of source value)

- Performance test data is recorded (as applicable) to each portable contamination survey instrument with signature upon completion
- For Ludlum 12-1A use the following guidelines when setting the selector switch
  - For X1000, press HV Test button, ensure reading is between 1 7 and 1 9 on the bottom scale (or as specified on the calibration tag)
  - For X1000 and Fast Response mode, place detector on highest value source on source board
  - For X100 and Fast Response mode, place detector on 2nd highest value source on source board
  - For X10 and Slow Response mode, place detector on 3rd highest value source on source board (X10 & X10 scales are averaged over 30 seconds)
  - For X1 and Slow Response mode, place detector on lowest value source on source board
- For Ludlum Model 31 use the following guidelines
  - Ensure background is < 100 cpm with the range selector switch set to X1 and Fast/Slow Response Mode set to "S" for slow Record background on RSFORMS-02 01-02
  - High Voltage (HV) test with instrument on the X1000 scale (Acceptable is between 1 7 and 1 9 on the bottom scales, or as specified on the calibration tag)
  - Verify the certification tag on the Certified Source Board to ensure that the due date of the certification has not expired
  - Select X1000 on instrument and Fast response Source check on highest value source
  - Select X100 on instrument and Fast response Source check on next lower value source
  - Select X10 on instrument and Slow response Source check on next lower value source
  - Select X1 on instrument and Slow response Source check on the lowest value source
  - Verify instrument readings on all scales are ±20% of source standard values

ROCKY FLATS ENVIRONMENTAL TECHNOLOGY SITE

SWIPE COUNTER PERFORMANCE LOG

INSTRUMENT MODEL: (Circle One) ALPHA ☐ BETA ☐

SAC-4 / BC-4 / LUDLUM 2929 Counter Serial No._____ Calibration Due Date: _____

Start Date:_____ End Date:_____ Building :_____ Location:_____

Source: S/N_____ D. P. M.:_____ Certification Due Date: _____

Date/Shift_____ Gross Source cpm_____ Time _____ Bkg. cpm._____ RCT Emp #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)	Date/Shift_____ Gross Source cpm:_____ Time _____ Bkg cpm _____ RCT Emp #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)
Date/Shift _____ Gross Source cpm _____ Time _____ Bkg. cpm _____ RCT Emp. #_____ Net Source cpm _____ _____ %Error:_____ (Print Name / Signature)	Date/Shift _____ Gross Source cpm _____ Time_____ Bkg. cpm _____ RCT Emp #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)
Date/Shift _____ Gross Source cpm _____ Time _____ Bkg cpm_____ RCT Emp. #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)	Date/Shift:_____ Gross Source cpm _____ Time:_____ Bkg cpm _____ RCT Emp. #_____ Net Source cpm _____ _____ %Error_____ (Print Name / Signature)
Date/Shift_____ Gross Source cpm:_____ Time _____ Bkg. cpm._____ RCT Emp #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)	Date/Shift _____ Gross Source cpm _____ Time_____ Bkg cpm._____ RCT Emp. #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)
Date/Shift _____ Gross Source cpm _____ Time _____ Bkg cpm _____ RCT Emp. #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)	Date/Shift _____ Gross Source cpm _____ Time _____ Bkg cpm _____ RCT Emp #_____ Net Source cpm _____ _____ %Error_____ (Print Name / Signature)
Date/Shift _____ Gross Source cpm _____ Time _____ Bkg cpm _____ RCT Emp. #_____ Net Source cpm _____ _____ %Error_____ (Print Name / Signature)	Date/Shift _____ Gross Source cpm _____ Time._____ Bkg cpm _____ RCT Emp #_____ Net Source cpm._____ _____ %Error._____ (Print Name / Signature)
Date/Shift _____ Gross Source cpm _____ Time _____ Bkg cpm _____ RCT Emp. #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)	Date/Shift _____ Gross Source cpm _____ Time _____ Bkg. cpm _____ RCT Emp #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)
Date/Shift _____ Gross Source cpm _____ Time _____ Bkg cpm _____ RCT Emp #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)	Date/Shift _____ Gross Source cpm _____ Time _____ Bkg cpm _____ RCT Emp. #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)
Date/Shift_____ Gross Source cpm _____ Time _____ Bkg cpm _____ RCT Emp. #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)	Date/Shift_____ Gross Source cpm _____ Time _____ Bkg cpm _____ RCT Emp #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)
Date/Shift _____ Gross Source cpm _____ Time _____ Bkg cpm _____ RCT Emp #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)	Date/Shift _____ Gross Source cpm _____ Time _____ Bkg Cpm _____ RCT Emp #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)
Date/Shift _____ Gross Source cpm _____ Time _____ Bkg cpm _____ RCT Emp #_____ Net Source cpm _____ _____ %Error _____ (Print Name / Signature)	% ERROR= $\frac{\text{(Net cpm/E)-Source dpm}}{\text{Source dpm}} \times 100$ Net cpm = gross – background cpm

E = Efficiency=0.33 for the SAC-4 and 0.25 for the BC-4

Approved by :_____ / _____ / _____ / _____

RS Supervision Print Name Signature Emp. # Date

PADC-1998-00382

Note: The number of performance test blocks may be adjusted provided all information within the blocks remains unchanged

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SWIPE COUNTER PERFORMANCE LOG

GUIDANCE:

- The appropriate instrument / source data, shift / date, and building location is recorded on RSFORMS-02.01-03.

- A background (Bkg) determination is performed as defined below
  - SAC-4, BC-4, Ludlum 2929. Perform a ten minute count to determine background
    1) SAC-4 and Ludlum 2929 alpha background must be less than 0 63 cpm for SAC-4 and 8 cpm for Ludlum 2929 (if not, perform a second background count If background is still 0 63 cpm or greater for SAC-4 and 8 cpm for Ludlum 2929, tag instrument out-of-service and notify RCT Supervision).
    2) BC-4 beta background must be less than 94 9 cpm (if not, perform a second background count. If background is still 94 9 cpm or greater, tag instrument out-of-service and notify RCT Supervision)
    3) Ludlum 2929 beta background must be between 50 cpm and 195 cpm (if not, perform a second background count. If background is still not between 50 cpm and 195 cpm, tag instrument out-of-service and notify RCT Supervision)

- The background cpm is recorded on RSFORMS-02 01-03 in the appropriate space

- Perform and record source count results in cpm on RSFORMS-02.01-03
  - SAC-4, BC-4, Ludlum 2929 Perform a one minute source count
    1) SAC-4 requires the use of a National Institute of Standards and Technology (NIST) Pu-239 source
    2) BC-4 requires the use of a NIST certified Sr/Y-90 source
    3) Ludlum 2929 requires the use of a NIST certified Th-230 or Pu-239 source with a value greater than 1500 dpm.
    4) Ludlum 2929 beta count requires the use of a NIST certified Sr/Y-90 source

- The percent error (%Error) is determined for the SAC-4, and Ludlum 2929 (alpha and beta) and record on RSFORMS-02 01 03 (%Error formula is located on RSFORMS-02 01 03)

- The % Error is verified within ± 20% for the SAC-4, BC-4 and Ludlum 2929 (alpha and beta)
  - If the %Error falls outside the ± 20% range, notify the RCT Supervisor and tag the instrument out-of-service

- Fill out Shift, Time, Employee Number, Print Name, and Sign RSFORMS-02 01 03

- Ensure a separate form is used for each instrument and type of count performed (i e Alpha or Beta)

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PORTABLE SCALER CONTAMINATION INSTRUMENT PERFORMANCE TEST LOG RSFORMS-02.01-04

INST TYPE/SERIAL # ____________________ CAL DUE DATE __________ INSTRUMENT EFFICIENCY (Alpha) ________ / (Beta) ________

PROBE S/N ____________________ BLDG ____________

This form is used to record parameters noted during daily performance checks on NE Electra, Bicron Frisk-Tech, Portable instruments with gas proportional detector Instruments that require additional repair or service are returned to Instrumentation Repair Facility

TIME/ DATE	RCT NAME/EMP #	IN CAL Yes No	BATT SAT Yes No	COUNT TYPE	BKG (cpm)	INSTRUMENT READING (Net cpm)	FLUSH/RE-CHARGE (N/A if not gas prop det) (Initials)	% ERROR ± 20% IN TOL (Initials)	RCT SIGNATURE
				Alpha					
				Beta					
				Alpha					
				Beta					
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				Beta					

* Guidance for use of this form is located on the back of the form

PADC-2000-03527

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PORTABLE SCALER CONTAMINATION INSTRUMENT PERFORMANCE TEST LOG RSFORMS-02.01-04

SOURCE ISOTOPE (Alpha) _____ (CSL)/(S/N)/(Registry No) _____ Certification/Decay Chart Date _____
(Circle One) (Circle One)

Source (dpm) _____ Range (cpm) ± 20% _____

SOURCE ISOTOPE (Beta) _____ (CSL)/(S/N)/(Registry No) _____ Certification/Decay Chart Date _____
(Circle One)

Source (dpm) _____ Range (cpm) ± 20% _____

Approved by RS Supervision			
/	/	/	
Name (print)	Signature	Employee #	Date

$$\%Error = \frac{(Net\ cpm - eff) - Source\ dpm}{Source\ dpm} \times (100)$$

Where Net cpm = Source cpm - Background cpm

GUIDANCE

- The appropriate instrument data and building location is recorded on RSFORMS-02 01-04
- Obtain an appropriate certified source or decay chart source for the instrument being tested
- A general inspection is performed on the instrument for the following
  - * Physical condition of the detector, cables, and instrument
  - * Instrument battery/power supply check is satisfactory
  - * Instrument audio check is satisfactory, as applicable
  - * Instrument light leak check is satisfactory, as applicable
  - * Instrument background response check is within tolerances of expected values (typically 1 minute count)
  - * Instrument corrected source count reading falls within an acceptable range (± 20% of source value typically using a 1 minute count)
- Performance test data is recorded (as applicable) to each portable contamination survey instrument with signature upon completion

Reviewed For Classification/UCNI
By _____
Date 20 MAR 01

EBERLINE BC-4
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I Instrument Characteristics

A Physical Description

A one-piece Beta detecting unit containing a Geiger-Mueller (GM) detector (shielded on the top and sides by a minimum of 7/8-inch thick lead), Corona tube regulated at 900 V, and direct coupled amplifier with approximately 400 mV input sensitivity

B Features

One piece unit, six decade light emitting diode (LED) readouts
Slide out sample holder
Preset count times (1, 2, and 5 minutes) with multipliers of X 1, X1, and X10

C. Scaler/Meter/Detector Configurations

The BC-4 is a complete system consisting of a two-inch GM detector, high voltage power supply, pulse amplifier, timer, and six decade LED readouts

II Instrument Specifications

A. MDA

The MDA is 200 dpm, based on a background of 94 9 cpm and an efficiency of 24% (most restrictive of 25% ± 1% efficiency)

B Types of Radiation Measured

Beta

C Ranges

The scaling range is between 0 and 999,999

D Energies

16 keV to 3 27 MeV

E Efficiencies

Overall Efficiency is 25% ± 1% Use 25% for the swipe counter performance log

F. Types of Batteries and Life

Operates on 115 or 230 ± 10% V AC switch selectable

G Sensitivity

Low level sensitivity is 400 mV

H Audio

This instrument has no audible outputs

I Linearity

The scaling range is between 0 and 999,999

J. Modes of Operation

Manual continuous count mode, or Timed count mode with various multiplication factors

K. Voltage Range

High voltage operating point is 900 VDC

L Alarm Range

No alarm capabilities

M Calibration Stability

Reproducibility Check ± 20% and a Time Base Test (Input 1200 cpm)

X 1 minute	Tolerance = 118 to 120 counts
X 2 minute	Tolerance = 238 to 242 counts
X 5 minute	Tolerance = 594 to 606 counts
X1 minute	Tolerance = 1188 to 1212 counts
X10 minutes	Tolerance = 11880 to 12120 counts

N Response Times

Not applicable

O Calibration Limitations

Calibrated every six months or after maintenance and/or repair

III Limiting Conditions of Operation

A Temperature

0°C to 60°C (32°F to 140°F)

B Barometric Pressure/Altitude

No observed effects

C Humidity

No observed effects

D. Chemical Interference

No observed effects

E Radio Interference

No observed effects

IV. General Operations

A. Switch Configuration/Function

Count Mode	Manual (continuous), Stop, and Timed (from 1 to 50 minutes)
Start/Reset Button	Resets the scaler output to zero and begins a new count
Timer Multiplier Switch	Multiplies the minutes selected for counting by 0 1, 1 0, or 10
Minutes Switch	Selects a count time of one, two, or five minutes
Power Switch	Switch to supply power to the instrument (Rear Panel)

B Background Counting

A 10 minute background count is performed each shift Ensure instrument control switches are set as follows **"ON"**, Multiplier **"X10"** (for background determination), Count Mode **"TIMED"**, Minutes **"1"**

C. Scan Rates

Not applicable for this instrument

D Scan Distance

Not applicable for this instrument

E Performance Test Requirements

Required to be performed prior to first use of the instrument on each shift

EBERLINE BC-4
INSTRUMENT TECHNICAL SPECIFICATION SHEET

F Operational Test Requirements

Ensure that a background determination and performance test has been performed on the current shift If background after a 10 minute count is ≥ 94 9 cpm, the instrument shall be submitted for repair (after planchet has been cleaned)
Ensure instrument control switches are set as follows Power **"ON"**, Multiplier **"X1"** (for counting), Count Mode **"TIMED"**, Minutes **"1"**

G Good Practices

Ensure that the planchet is decontaminated prior to use, to ensure a low background
Ensure there are no smears remaining in the detector (stuck on the detector window) prior to use
When using tweezers to handle samples, care must be exercised to avoid scratching the swipe counter sample holder

H. Maintenance Allowed by User

Cleaning of sample holder planchets

EBERLINE SAC-4
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A Physical Description

Scintillation phosphor on a plastic light pipe with photomultiplier tube, in conjunction with high voltage power supply, charge-sensitive input amplifier, timer, and six decade light emitting diode (LED) readout This instrument is used for alpha detection

B. Features

One piece unit, six decade LED readouts
Preset count times (1, 2, and 5 minutes) with multipliers of X 1, X1, and X10

C. Scaler/Meter/Detector Configurations

The SAC-4 is a complete system consisting of a two inch scintillation detector, high voltage power supply, charge-sensitive input amplifier, timer, and six decade LED readouts

II. Instrument Specifications

A Minimum Detectable Concentration (MDC)

Based on a maximum background of 0 63 cpm and an efficiency of 32%, (lower limit of acceptable efficiency), the MDC for the SAC-4 is 20 dpm

B. Types of Radiation Measured

Alpha

C Ranges

Six decade readout in cpm The scaling range is between 0 and 999,999

D. Energies

3 83 MeV to 8 78 MeV

E Efficiencies

Efficiency is 33%

F Types of Batteries and Life

Operates on 115 or 230 ± 10% Volts AC switch selectable

G Sensitivity

Discrimination is internally biased at 1 25 V

H Audio

This instrument has no audible outputs

I Linearity

The scaling range is between 0 and 999,999

J Modes of Operation

Manual continuous count mode, or Timed count mode with various multiplication factors

K Voltage Range

Regulated variable by a rear panel control to approximately 1500 V

L Alarm Range

No alarm capabilities

M Calibration Stability

The mean instrument response at constant temperature and pressure is assumed not to vary by more than 6% from the mean of a set of reference readings over a period of 24 hours for AC-powered units after a warm-up period of not less than 10 minutes

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N Response Times

Not applicable

O. Calibration Limitations

Calibrated every six months or after maintenance and/or repair

III. Limiting Conditions of Operation

A Temperature

0°C to 60°C (32°F to 140°F)

B. Barometric Pressure/Altitude

Not measured

C Humidity

Not measured

D. Chemical Interference

Not measured

E. Radio Interference

Not measured

IV. General Operations

A. Switch Configuration/Function

Count Mode	Manual (continuous), Stop, and Timed (from 0 1 to 50 minutes)
Start/Reset Button	Resets the scaler output to zero and begins a new count
Timer Multiplier Switch	Multiplies the minutes selected for counting by X 1, X1, and X10
Minutes Switch	Selects a count time of one, two, or five minutes
Power Switch	Switch to supply power to the instrument (rear panel)

B Background Counting

A 10 minute background count is performed each shift Ensure instrument control switches are set as follows Power "**ON**" Multiplier "**X10**" (for background determination), Count Mode "**TIMED**", Minutes "**1**"

C Scan Rates

Not applicable

D Scan Distance

Not applicable

E Performance Test Requirements

Required to be performed prior to first use of the instrument on each shift If background count is ≥ 0 63 cpm, the instrument shall be submitted for repair (after attempting to decontaminate the planchet and sample holder)

F Operational Test Requirements

Ensure that a background determination and performance test has been performed on the current shift Ensure instrument control switches are set as follows Power "**ON**", Multiplier "**X1**" (for counting), Count Mode "**TIMED**", Minutes "**1**"

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G. Good Practices

Pre-screen samples prior to counting.
Ensure that the planchet is decontaminated prior to use, to ensure a low background
Ensure there are no swipes (smears) remaining in the detector (stuck on the detector window) prior to use
When using tweezers to handle samples, care must be exercised to avoid scratching the swipe (smear) counter sample holder

H. Maintenance Allowed by User

Radiological Control Technicians are allowed to perform a decontamination on the instrument planchet sample holder

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EBERLINE RO-20
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

Portable air ion chamber instrument used to detect beta, gamma, and x-ray radiation It measures 4 2" wide, 7 9" long, 7 7" high (including handle), and weighs 3 6 lb (including batteries) The instrument casing and sliding "beta" window are 1000 mg/cm^2

B Features

- Measures gamma or x-ray exposure rate
- Temperature compensated measurements
- Large backlit display
- Long battery life
- Non-mechanical ranging switch

C Scaler/Meter/Detector Configurations

One piece meter and air vented ion chamber contained in a metal casing

II. Instrument Specifications

A MDDR

1 milliroentgen per hour, 1 mR/hr (based on site guidance, using 20% of the top end of the lowest calibrated scale of 0-5 mR/hr)

B Types of Radiation Measured

Beta, gamma, and x-ray

C. Ranges

5 linear ranges 0-5, 0-50, 0-500 mR/hr and 0-5, 0-50 R/hr

D Energies

0 57 keV to 2 73 MeV photons

E Efficiencies

Photon Energy Response	± 30% from 8 keV to 1 3 MeV with the open slide facing the source ± 15% from 33 keV to 1 3 MeV with the closed slide facing the source ± 15% from 55 keV to 1 3 MeV through the side of the instrument
Beta Response	Uranium slab 30% of true mrad/hr field behind 7 mg/cm^2 window with RO-20 resting on slab, slide open A correction factor of 4 is applied to the net reading (open window reading minus closed window reading) when measuring depleted uranium Sr/Y-90 Approximately 93% of true mrad/hr field at 30 cm with slide open

F. Types of Batteries and Life

Main power Five "C" cells

Chamber bias Ten, 3 V lithium coin cells, 30 V

- Typical ZnC mR/hr ranges, 2900 hours All other ranges, 150 hours
- Typical Alkaline mR/hr ranges, 6900 hours All other positions, 350 hours

G. Sensitivity

- If the instrument is over ranged by exposure to gamma radiation, it will indicate off scale and shall remain so until the radiation field is reduced to below full scale (When the radiation field is removed, the instrument reading shall return to the expected value within 2 minutes)
- Showed no response to alpha activity
- Manufacturer's specifications state a response of up to 8% for fast neutron fields

H. Audio

No audible response for this instrument

I. **Linearity**

Within ± 5 percent of full scale

J. **Modes of Operation**

Gamma/x-ray radiation detection
Beta radiation detection (for depleted uranium a correction factor of 4 is applied to the net reading)

K **Voltage Range**

The ion chamber structure is maintained at chassis potential (ground), the center electrode is maintained at -30 V by the 30 V bias battery

L **Alarm Range**

No alarm capabilities

M. **Calibration Stability**

Performance Test (As found)	± 20% on 0-50 mR/hr range, with known source
Reproducibility Test (As found)	± 10% on 0-50 mR/hr range, with known source

N **Response Times**

5 seconds, 10 to 90 percent of final reading for each scale

O. **Calibration Limitations**

Calibrated every six months or after maintenance and/or repair
± 10% Reproducibility, Linear Range Adjustment, and Linear Range Check

III. Limiting Conditions of Operation

A **Temperature**

Operable from -40°F to 140°F (-40°C to 60°C) For operation below 0°F (18°C), alkaline or nickel cadmium "C" cells should be used

B. **Barometric Pressure/Altitude**

The instrument is sensitive to changes in atmospheric pressure The Technical Basis Document gives correction factors to be used if the RO-20 is used at an elevation other than that when calibrated Normal atmospheric pressure variations on plantsite have minimal effect

C **Humidity**

Usable at 0-95 percent relative humidity

D. **Chemical Interference**

None

E **Radio Interference**

When operated on the 0 - 5 mR/hr range, susceptibilities were indicated at various frequencies

IV. General Operations

A **Switch Configuration/Function**

Rotary switch for Off, Battery 1 check, Battery 2 check, Zero, 5, 50, 500, mR/hr, 5-50 R/hr, light switch, and zero adjust knob

B. **Scan Rates**

Limited by 5 second response times referenced in II N

C. **Scan Distance**

Contact or general area readings may be taken

EBERLINE RO-20
INSTRUMENT TECHNICAL SPECIFICATION SHEET

D Performance Test Requirements

Daily performance test to include

Check *Battery 1* ("C" cells) and *Battery 2* (lithium cells) Do not leave the switch in the *Battery 2* position for more than 5 seconds
Check *Zero* adjust position
Check for proper operation of meter light
Check for proper meter response against a known source

E. Operational Test Requirements

Performed daily by Health Physics Instrumentation

F. Good Practices

- Ensure proper response time is allowed
- When down ranging the instrument from 0-5 or 0-50 R/hr, stop at the 0-500 mR/hr range and allow the meter indication to stabilize before down ranging further (This minimizes the meter spike due to electronic noise)
- Ensure that the sliding window is closed (for gamma measurements)
- Enter area on range selection greater than anticipated, then downscale as appropriate

G Maintenance Allowed by User

User is not allowed to perform <u>any</u> maintenance on the instrument (NO battery changing allowed)

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LUDLUM MODEL 12-1A WITH AIR PROPORTIONAL PROBE
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A Physical Description

A lightweight, portable, battery operated handheld instrument, with an air proportional probe for alpha detection For surface-contaminated-objects (SCO) measurements, a specially modified Ludlum 12-1A with an attached attenuator plate to the face of the air proportional probe and a ten foot cable is used The attenuator plate is 0 038 inches thick with an 8-segment dual row hole pattern

B Features

Portable instrument capable of interfacing with several types of radiation detectors (air proportional used at RFETS)
Linear analog scale indicating values from 0-1000 cpm when used without an attenuator plate (i e , standard mylar screen)
For SCO measurements, a linear analog scale from 0-500 cpm when used with attenuator plate
Operates with four ranges X1, X10, X100, and X1K
Fast and slow response modes of operation
Connector for interfacing with a pair of headphones for audible indication of response

C Scaler/Meter/Detector Configurations

Ludlum Model 12-1A count ratemeter configured with 0-1000 cpm full scale meter with non attenuated air proportional probe or 12-1A configured with 0-500 cpm full scale meter with an attenuated plate to the face of the air proportional probe

II. Instrument Specifications

A MDA

Not applicable to rate meters, however, assuming smallest observable deflection of meter needle is 30 cpm, a justifiable level of detection while stationary would be approximately 500 dpm/100 cm^2 for fast response and 200 dpm/100 cm^2 for slow response

B Maximum Operating Range

For SCO measurements, the maximum operating range is 0-250,000 cpm for a metal screen (attenuator plate)

C. Types of Radiation Measured

Alpha surface contamination

D. Ranges

0-1000, 10,000, 100,000, and 1,000,000 cpm for standard mylar screen probe

0-500, 5,000, 50,000, and 500,000* cpm for a metal screen probe used in SCO measurements

*Note (250K is the upper limit allowed)

E Energies

3 83 MeV to 8 78 MeV

F Efficiencies

7% for the air proportional probe, electronically adjusted to 50% (Correction Factor = 2) with standard mylar screen

For SCO measurements using a metal screen (attenuator), efficiency is typically less than 0 1%

G Types of Batteries and Life

Two standard "D" cells
Minimum continuous operation of 100 hours, the response of the instrument does not vary more than 10% during this time

H Sensitivity

25

Adjustable from 2 to 60 mV

I Audio

The instrument has a connector for interfacing with a pair of headphones or ear plugs for audible indication of response

J Linearity

± 10% of the equivalent source value and ranges from 0 to 1,000,000 counts per minute (cpm) for standard mylar screen

± 10% of the source value and ranges from 0 to 250,000 counts per minute (cpm) for SCO measurements using attenuator plate (metal screen)

K Modes of Operation

"Fast" and "Slow" response modes
Functions with an alpha air proportional probe

L Voltage Range

Variable from 200 - 2500 V

M Alarm Range

No alarm capabilities

N Calibration Stability

Less than 5% variance to battery endpoint

O Response Times

Fast response time of 4 ± 1 seconds for 90% of final meter reading in the Fast Response Mode
Slow response time of 22 ± 4 seconds for 90% of final meter reading in the Slow Response Mode

P Calibration Limitations

Ludlum Model 12-1A configured with an air proportional probe must be calibrated in a temperature controlled environment at annual intervals For SCO measurements, the modified Ludlum Model 12-1A configured with an attenuated metal screen over the face of the air proportional probe must be calibrated in a temperature controlled environment at six month intervals

III. Limiting Conditions of Operation

A Temperature

This instrument should not be used below 64°F (18°C), it can be used up to 122°F (50°C)
Air proportional probe is very sensitive to temperature changes and is mainly used indoors

B. Barometric Pressure/Altitude

This instrument over responds when subjected to ambient pressures above normal and under responds when subjected to ambient pressures below normal Do not operate this instrument in areas other than normal atmospheric pressure

C. Humidity

Instrument's response shall not vary by ± 15% over the relative humidity (RH) range of 40% to 95% at 71°F (22°C) when compared to the reference response at 40% RH and 71°F (22°C)

D Chemical Interference

Carbontetrachloride (CCl_4) fumes will cause the air proportional probe to not respond

E Radio Interference

Instrument is susceptible to radio frequency interference and should not be operated within six feet of two-way radios that are in use

IV. General Operations

A Switch Configuration/Function

"Fast" or "Slow" response toggle switch
6 position rotary switch to battery test, turn off, and change ranges
Depressing the RES switch will zero the meter
Depress the HV switch, the meter should read detector high voltage

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LUDLUM MODEL 12-1A WITH AIR PROPORTIONAL PROBE
INSTRUMENT TECHNICAL SPECIFICATION SHEET

B. Scan Rates

i **12-1A with Standard Mylar Screen Air Proportional Probe**

Stationary	Fast response ≈ 500 dpm/100 cm^2
	Slow response ≈ 200 dpm/100 cm^2
Scan	@ 2"/sec (MDA ≈ 20,100 dpm/100 cm^2)

ii **12-1A with Attenuated Air Proportional Probe for SCO Measurements**

Stationary	In either fast or slow response ≈ 500,000,000 dpm/100 cm^2 (roughly 250,000 cpm max reading)

SCO measurements are based on the count rate, divide by the efficiency (results will be in dpm/50 cm^2) and then multiply results by 2 to get 100 cm^2 [i e , (c/m ÷ eff) x 2] The upper range limit for the assembly of Ludlum 12-1A with attenuated Air Proportional Probe is 250,000 cpm Linearity for readings above 250,000 cpm has not been established Do not exceed 250,000 cpm when making SCO measurements The efficiency for the probe/cable pair provided is entered on the efficiency tag for the probe

Scan	Limits not established for scan measurements

C Scan Distance

¼ inch from surface being surveyed

D Performance Test Requirements

i. **12-1A with Standard Mylar Screen Air Proportional Probe**

Daily performance test to include

Battery test prior to use
High Voltage (HV) test with instrument on the X1000 scale (acceptable is between 1 7 and 1 9 on the bottom scales, or as specified on the calibration tag)
Verify the certification tag on the Certified Source Board to ensure that the due date of the certification has not expired

Select X1000 on instrument and Fast response Source check on highest value source
Select X100 on instrument and Fast response Source check on next lower value source
Select X10 on instrument and Slow response Source check on next lower value source
Select X1 on instrument and Slow response Source check on the lowest value source
Verify instrument readings on all scales are ± 20% of source standard values

ii. **12-1A Attenuated Air Proportional Probe for SCO Measurements**

Performance Test prior to use only

Battery test prior to use
High Voltage (HV) test with instrument on the X1000 scale (acceptable is between 1 7 and 1 9 on the bottom scales, or as specified on the calibration tag)
Verify the certification tag on the Certified Source Board to ensure that the due date of the certification has not expired

Select X10 on instrument and Slow response Source check on the highest source

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LUDLUM MODEL 12-1A WITH AIR PROPORTIONAL PROBE
INSTRUMENT TECHNICAL SPECIFICATION SHEET

E Operational Test Requirements

i **12-1A with Standard Mylar Screen Air Proportional Probe**
Routine operational checks are performed
at the following minimum periods
- After each personnel monitoring
- Every 15 minutes when the instrument is in continuous use
- Prior to each intermittent use
- After probe replacement

Verify proper audible response, needle deflection, and ± 20% readings when checked with the appropriate check source

ii **12-1A Attenuated Air Proportional Probe for SCO Measurements**
Operation tests are not feasible while applying SCO measurements

F Good Practices

Do not contact the probe surface with the contaminated surface
Protect instrument from temperature and humidity extremes
Do not puncture thin detector window
Shall not be used for survey for unrestricted release of any type, to include personnel

G Maintenance Allowed by User

i **12-1A with Standard Mylar Screen Air Proportional Probe**
Air proportional probes may be changed as long as the performance test and operational check requirements are met
User may change batteries

ii ***12-1A Attenuated Air Proportional Probe for SCO Measurements***
No other maintenance is allowed except battery changes

LUDLUM MODEL 31 WITH LUDLUM MODEL 44-9 PANCAKE GM DETECTOR INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The Model 31 is a portable beta-gamma contamination survey instrument that operates on two standard "D" cell batteries The instrument features a regulated high-voltage power supply, adjustable from 400 to 1500 V and provides four linear ranges from 0 - 1,000,000 cpm

B. Features

Fast and slow response modes of operation
Audible external speaker and headphones
Lightweight, portable, durable, and battery operated

C. Scaler/Meter/Detector Configurations

Ludlum Model 31 survey instrument with Ludlum Model 44-9 Pancake Geiger-Mueller (GM) Detector

II Instrument Specifications

A. MDA

Stationary (Pat Method) response
Based on a background of 100 cpm and an efficiency of 33%
Static MDA is 994 dpm/100 cm^2 (approximately 1,000 dpm/100 cm^2)

B. Types of Radiation Measured

Beta-gamma.

C. Ranges

0-1000, 10,000, 100,000, 1,000,000 cpm

D. Energies

Isotopic Beta Energy Range	16 keV to 3 54 MeV (max)

E Efficiencies

Beta	33 3% ± 1% (Correction Factor = 3)
Gamma	2100 cpm/mR/hr for Cs-137

F. Types of Batteries and Life

Two standard "D" cells with a typical battery life of 200 hours.

G. Sensitivity

40 mV

H. Audio

Instrument has external speaker and headphone jack

I Linearity

± 5% full scale

J Modes of Operation

Instrument can operate in the "Fast" or "Slow" response mode for detection of surface contamination

K. Voltage Range

Externally adjustable from 400 to 1500 V, the instrument is set for 900 V, G-M tube operation

L Alarm Range

No alarm capabilities

M. Calibration Stability

Reproducibility Test (As found)	± 10%
Performance Test (As found)	± 20%

N Response Times

Fast Response Mode	4 seconds ± 1 second for 90% of final meter reading
Slow Response Mode	22 seconds for 90% of final meter reading

O Calibration Limitations

Calibrated every six months or after maintenance and/or repair

III. Limiting Conditions of Operation

A Temperature

Do not operate outside of 32°F to 150°F (0°C to 65°C) unless the following conditions are met

Install new batteries
Limit operations to 10 hours

B Barometric Pressure/Altitude

No observed effects

C Humidity

No observed effects

D Chemical Interference

No observed effects

E Radio Interference

No observed effects

IV. General Operations

A Switch Configuration/Function

Meter reset switch	Resets the meter to zero when depressed
Fast-slow meter response switch	Speeds up or slows down the response/display of the meter
Six position, multifunction switch	Used for Off, Battery Check, X1, X10, X100, and X1000 scale multiples

B. Scan Rates

1 to 2 inches/second for general use when used with audible response

C. Scan Distance

Within ½ inch of surface

D. Performance Test Requirements

Daily performance test to include

Battery test prior to use
High Voltage (HV) test with instrument on the X1000 scale (acceptable is between 1 7 and 1 9 on the bottom scales, or as specified on the calibration tag)
Verify the certification tag on the Certified Source Board to ensure that the due date of the certification has not expired
Select X1000 on instrument and Fast response Source check on highest value source

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Select X100 on instrument and Fast response Source check on next lower value source
Select X10 on instrument and Slow response. Source check on next lower value source
Select X1 on instrument and Slow response Source check on the lowest value source
Verify instrument readings on all scales are ± 20% of source standard values

E. Operational Test Requirements

Routine operational checks are performed at the following minimum periods

After each personnel monitoring
Every 15 minutes when the instrument is in continuous use
Prior to each intermittent use
After probe replacement

Verify proper audible response, needle deflection, and ± 20% readings when checked with the appropriate check source

F. Good Practices

Ensure Performance Test and Operational Requirements are met
Do not contact the probe surface with the contaminated surface

G Maintenance Allowed by User

User is allowed to change only the coaxial cord and batteries

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BICRON FIDLER
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A Physical Description

The Harshaw / Bicron FIDLER is a light-weight, portable count-rate instrument that utilizes a five-inch Sodium Iodide (NaI[Tl]) scintillator combined with an Analyst counter/scaler (single channel analyzer) to directly read low level/energy gamma and x-rays on large surfaces The detector is wide and thin and therefore highly directional

B Features

Light-weight, battery operated (portable)
Large scintillation detector

C. Scaler/Meter/Detector Configurations

Analyst counter/scaler with the G5 FIDLER Probe

II. Instrument Specifications

A MDA

Stationary 1053 3 dpm (This is an ideal MDA calculation assuming an optimum static source geometry Motion, *distance, etc will dramatically increase this value)*

B. Background Decision Levels

If survey is in a known radiological area 2 times background (RFETS assumed Background is 2,000 cpm) 4,000 cpm indicates activity above background

If survey is not in known radiological area Area not expected to contain activity = Background $+ 2x \sqrt{BKG}$

C Types of Radiation Measured

Low level/low energy gamma and x-ray emitters

D. Ranges

0-500, 0-5000, 0-50,000, and 0-500,0000 cpm

E Energies

15 keV to 1 MeV (Peak centered at 17 keV utilizing Am -241)

F Efficiencies

20% (Average) (Correction Factor = 5)

G Types of Batteries and Life

One 9-V battery (MN1604 or equivalent) which lasts 50 hours typically The additional battery holder may be used for storage of spare or parallel-wired (100 hour life with parallel option)

H Sensitivity

Low-level discriminator adjustable from <0 1 to 1V with internal potentiometer

I Audio

A built-in speaker provides audible "click" for each detector pulse

J Linearity

± 5% from 400 to 1600 V

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K. Modes of Operation

The Analyst counter/scaler has a single channel analyzer with three modes of operation

Channel 1 (Window Mode)	This mode provides energy discrimination by accepting only those detector pulses within a certain range or window Channel 1 counts all pulses between the lower and upper level discriminators
Channel 2	Counts all pulses above the upper level discriminator
Out (Gross Counting Mode)	Accepts all signals above the lower-level discriminator

L. Voltage Range

Electronically stabilized and adjustable, 400 to 1600 V with readout on the meter

M Alarm Range

Over range alarm may be selected to respond to 30% of full scale

N. Calibration Stability

Source Response (As Found)	± 20%
Source Reproducibility Test (As Found)	± 10%

O. Response Times

Response time is switch selectable, optimized for each range, 10-90% of final reading as follows

X1	12 sec (Fast)	20 sec (Slow)
X10	1 sec (Fast)	8 sec (Slow)
X100	<1 sec (Fast)	2 sec (Slow)
X1000	<1 sec (Fast)	1 sec (Slow)

P Calibration Limitations

Calibration required yearly or after maintenance and/or repair

III. Limiting Conditions of Operation

A Temperature

Below 39°F, this instrument is limited to a 30 minute field operating use A minimum one hour warm-up period at indoor room temperature is required between each half-hour of use

B. Barometric Pressure/Altitude

No observed effects

C Humidity

No observed effects

D Chemical Interference

No observed effects

E. Radio Interference

No observed effects

F Hydroscopic

Detector is hermetically sealed and if the seal is compromised, then the performance/response will degrade

BICRON FIDLER
INSTRUMENT TECHNICAL SPECIFICATION SHEET

IV. General Operations

A. Switch Configuration/Function

Seven position rotary switch — Off, bat , HV, X1000, X100, X10, X1
Fast/Slow Response, Channel Switch, audio ON/OFF switch

B Scan Rates

Scan as slowly as possible to give the instrument time to respond Scan rates above two inches per second drastically reduce the probability of detection

Perform a one minute stationary count if readings above background are detected

C Scan Distance

At least 12 inches from the item being surveyed if the item is much larger than the detector
Hold the detector on contact if the item is the same size or smaller than the detector
For soil surveys performed in SITU place detector on the ground surface

D. Performance Test Requirements

Required to be performed every 24 hours of operational use by Health Physics Instrumentation

E. Operational Test Requirements

Prior to using the instrument perform the following checks
- Ensure calibration is current
- Inspect instrument for physical damage
- Ensure Performance Test requirements are met
- Perform a battery check and ensure that the needle reads in the BAT OK region

F. Good Practices

Listen to audible response closely since it responds faster than the instrument meter reading
Use proper care not to damage the extremely thin and fragile window on the scintillation detector

G. Maintenance Allowed by User

None (except for battery replacement)

MODEL 111 - TRITIUM MONITOR
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A Physical Description

One-piece unit with positive displacement sample pump, a submicron particulate filter, an ionization chamber, flow sensor, and associated electronics

B Features

Two linear and two logarithmic ranges
Built-in rechargeable batteries from a 115VAC line (Can operate on line or battery voltage)
Air output adapter for optional exhaust tubing
Alarm recorder jack for optional recorder or external alarm
Adjustable alarm settings and controls
Gamma radiation compensated to 5 mR/hr

C Scaler/Meter/Detector Configurations

Johnson Triton Model 111 Tritium Monitor

II Instrument Specifications

A MDA

No data available

B. Types of Radiation Measured

Low energy beta

C Ranges

0-50, 0-500 $\mu Ci/m^3$ linear, 10^1 to 10^4 Log $\mu Ci/m^3$, 10^3 to 10^8 Log $\mu Ci/m^3$

D Energies

18 6 keV, E_{MAX}, 5 685 keV, E_{AVE}

E Efficiencies

No data

F Types of Batteries and Life

Rechargeable 12 V sealed lead acid battery with at least an eight hour operation time

G Sensitivity

1 $\mu Ci/m^3$

H Audio

Audible alarm with an on-off-reset switch

I Linearity

± 10% of full scale on linear ranges, ±20% of full scale on LOG scales

J Modes of Operation

Operates on line voltage or battery voltage

K Voltage Range

100 to 130 V

L Alarm Range

25$\mu Ci/m^3$ (typically), adjustable for the full range displayed

M Calibration Stability

Response tolerance and reproducibility test ± 10%

N Response Times

30 seconds for the most sensitive range (0-50 $\mu Ci/m^3$ linear), <20 seconds for the other ranges

O. Calibration Limitations

Calibrated every six months or after maintenance and/or repair

III. Limiting Conditions of Operation

A. Temperature

32°F (0°C) to 122°F (50°C), provided that the instrument temperature and air dewpoint produce no condensation or frosting on, or within, the instrument

B Barometric Pressure/Altitude

Use the instrument at the same elevation it is calibrated at

C. Humidity

Instrument's response shall not vary by ± 15% over the relative humidity (RH) range of 40% to 95% at 71°F (22°C) when compared to the reference response at 40% RH and 71°F (22°C) Note instrument not tested outside of range

D Chemical Interference

No observed effects

E. Radio Interference

Do not operate two-way radios within six feet of this instrument

IV. General Operations

A Switch Configuration/Function

Alarm-Off-On-Reset	Turns alarm on or off, or resets an existing alarm
Alarm Up-Down Switch	Sets alarm level
Audible Alarm Reset	Resets audible alarm but does not reset the alarm relay or alarm visual display
Function Switch	Used to range or to check the zero or battery condition
Pump Switch	Turns the air sample pump on or off
Power Switch	Turns power on or off to the instrument
Offset Control	Used to compensate for external radiation (zero and the two linear ranges only)
Zero Adjust	Used to set the electrometer to zero

B Scan Rates

Not applicable

C Scan Distance

Not applicable

D Performance Test Requirements

Health Physics Instrumentation has to performance test prior to use

E. Operational Test Requirements

The following must be performed prior to using the instrument
Verify Health Physics Instrumentation has recorded a Performance Test of the instrument for the day of use
Visually check the calibration label to ensure that it is current
Perform a general condition check of the instrument
Conduct an Instrument Functional Test to verify proper display panel readings
Perform a Battery Check and a Zero Check

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F. Good Practices

Ensure that a clean, two-inch diameter, filter element is properly installed, with the rough side facing out, in the inlet filter housing

To avoid damaging the electrometer, do NOT power up the instrument until the Function Switch is in the ZERO position

G. Maintenance Allowed by User

None

NE ELECTRA/ELECTRA PLUS
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

NE Technology Electra/Electra Plus Model with DP6BD/DP8A Dual Scintillation Probe or AP6 Alpha Probe, portable ratemeter/scaler, used for the detection of alpha and beta radiation fields The alpha probe uses a ZnS phosphor The dual scintillation probe uses a ZnS phosphor (alpha detection) painted on a 1 mm thick plastic scintillator (alpha/beta detector) The relatively high signal output from interactions of alpha particles in the ZnS layer and the relatively low output from beta particles in the plastic scintillator provide corresponding electronic pulse amplitude distributions that can be used to differentiate between alpha and beta contamination during the same measurement process These instruments can also operate in the "Rate" mode or the "Integrate" mode and the Electra Plus offers the capability of data logging

B. Features

- Real-time digital analysis
- Background subtraction
- Integrated count rate and upper threshold adjustable from the keypad
- Autoranging bargraph display for ease of reading
- Display and control capabilities can be configured to suite individual circumstances
- Peak Hold and Sampler modes*
- I-Button™ or Barcode compatible *
- Data logging of up to 1000 data points (two channels) *
- Serial communication mode*
- Ratemeter with reset function*

* indicates available on Electra Plus model only

C. Scaler/Meter/Detector Configurations

NE Electra Plus Ratemeter with Model DP8A or Model AP6 NE Electra with DP6BD dual scintillation alpha/beta probe
Note The DP8A and AP6 are identical in appearance – differentiated by the Restricted Use Tags applies to the detector case

II. Instrument Specifications

A. The following are typical examples of PAT MDCs.

Source	Probe	t_s (s)	t_g (s)	Bkg (cpm)	Efficiency	MDC (dpm/100 cm²)
Alpha (Pu-239)	DP6BD	60	60	0 8	20%	34
Alpha (Pu-239)	DP6BD	60	60	8	17%	94
Beta (Sr/Y-90)	DP6BD	60	60	513	34%	318
Alpha (Pu-239)	DP8A	4	4	15	14%	131
Alpha (Pu-239)	DP8A	8	8	15	16%	73

The following are typical examples of scan MDCs.

Source	Probe	Scan Speed (in/s)	Bkg (cpm)	Efficiency	MDC (dpm/100 cm²)
Alpha (Pu-239)	DP6BD	0 65	0 8	20%	485
Alpha (Pu-239)	DP6BD	2	0 8	20%	1699
Beta (Sr/Y-90)	DP6BD	0 65	513	34%	4540
Beta (Sr/Y-90)	DP6BD	2	513	34%	15887

Note 1 the assumed surface to detector distance for scanning is ¼ of an inch for alpha, 1/2 of an inch for beta
Note 2 If either background, surface to detector distance, or scan speed increases or efficiency decreases, then the corresponding MDCs will increase in magnitude
Note 3 See RSP 02 01 for derivation of MDCs The alpha scan rate should be determined based on the acceptable probability of detection and regulatory criteria
Note 4 Scan rates for the DP8A are yet to be determined at Rocky Flats
Note 5 PAT and Scan MDC's for the AP6 are yet to be determined at Rocky Flats

NE ELECTRA/ELECTRA PLUS
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

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NE Technology Electra/Electra Plus Model with DP6BD/DP8A Dual Scintillation Probe or AP6 Alpha Probe, portable ratemeter/scaler, used for the detection of alpha and beta radiation fields The alpha probe uses a ZnS phosphor The dual scintillation probe uses a ZnS phosphor (alpha detection) painted on a 1 mm thick plastic scintillator (alpha/beta detector) The relatively high signal output from interactions of alpha particles in the ZnS layer and the relatively low output from beta particles in the plastic scintillator provide corresponding electronic pulse amplitude distributions that can be used to differentiate between alpha and beta contamination during the same measurement process These instruments can also operate in the "Rate" mode or the "Integrate" mode and the Electra Plus offers the capability of data logging

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- Background subtraction
- Integrated count rate and upper threshold adjustable from the keypad
- Autoranging bargraph display for ease of reading
- Display and control capabilities can be configured to suite individual circumstances
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NE Electra Plus Ratemeter with Model DP8A or Model AP6 NE Electra with DP6BD dual scintillation alpha/beta probe
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Note 5 PAT and Scan MDC's for the AP6 are yet to be determined at Rocky Flats

B. Types of Radiation Measured

Alpha or Beta, incidental gamma and neutron

- The DP8A has only been qualified for alpha radiation at the RFETS
- The AP6 is configured only to detect alpha

C. Ranges

- 0 1 cps to 100,000 cps
- 1 cpm to 1,000,000 cpm

D. Energies

- Alpha 3 83 MeV - 8 78 MeV
- Beta 16 KeV - 3.27 MeV (max) [dual phosphor probes only]

E. Efficiencies

- AP6 Alpha. (Pu-239) Minimum 14%
- DP6BD Alpha. (Pu-239) Minimum 17% (typically 18-20%)
- DP6BD Beta. (Sr/Y-90) Minimum 28% (typically 30-33%)
- DP8A Alpha (Pu-239) Minimum 14% (typically 14-16%)
- DP8A Beta (Sr/Y-90) Manufacturer spec 18% (Yet to be determined at Rocky Flats)

F. Types of Batteries and Life

- "3" C-cells with a typical life of greater than 90 hours

G Sensitivity

- AP6 probe surface sensitivity yet to be determined at Rocky Flats
- DP6BD probe surface sensitivity tolerance is ± 15%
- DP8A probe surface sensitivity yet to be determined at Rocky Flats

H. Audio

- External audible loudspeaker indication and a headphone/earpiece connector One click for each detected particle, different sounds for alpha and beta, alarm condition, or change of display

I. Linearity

± 10% (Electra/Electra Plus)

J. Modes of Operation

- Rate Mode Each second, the latest 1-second count is compared with the 16-second rolling average If the difference is significant the 1-second value is displayed, otherwise a new 16-second rolling average is displayed. The NE Electra/Electra Plus can also display rolling averages calculated over periods of between 1 and 25 seconds
- Integrate Mode Integrate Mode offers precise digital readout without the need for averaging techniques required by conventional ratemeters The Electra plus allows the user to specify the degree of precision (0 1-20%)
- Peak Hold Electra Plus only, updates the display only with new maximum readings and beeps for each new maximum
- Sampler Mode Electra Plus only, allows multiple integrations to be performed with fixed pause times between each integration

Recommended that the 5 second response time setting be used to keep readout fluctuations minimized.

K. Voltage Range

- High Voltage 400 -1400 volts for load resistance

L. Alarm Range

- 0 1 to 50,000 cps
- 1 to 300,000 cpm

Independent values can be set for alpha and beta (generally set to 500 cpm alpha and 5000 cpm beta)

M. Calibration Stability

As found value must be within ±10% of the previous calibration reference reading

N. Response Times

- 16 second rolling average in steady fields with FAST one second reaction time to significant changes.
- Rolling average, adjustable average period 1 to 25 seconds. - (recommended response period is 5 seconds)
- INTEGRATE mode, 10 to 5000 seconds in 10-second steps. Integrate mode, 1-10 sec in 1-sec steps, 15-30 sec in 5-sec steps, 40 to 5000 seconds in 10-second steps

O. Calibration Limitations

- The Electra/Electra Plus will be calibrated by qualified HPI personnel every six months, or after maintenance/repair

III. Limiting Conditions of Operation

A. Beta Radiation

- The DP8A has not been qualified for beta radiation surveys at this time.

B. Temperature

- The AP6 should not be operated below 25°F (-4°C) or above 104°F (40°C).
- The DP6BD should not be operated below -40°F (-40°C) or above 104°F (40°C) for detection of alpha radiation (up to 9% deviation of meter readings between these temperature ranges)
- The DP6BD should not be operated below -5°F (-30°C) or above 86°F (30°C) for detection of beta radiation. (up to 15% deviation of meter readings between these temperature ranges)
- The DP8A should not be operated below 32°F (0°C) or above 104°F (40°C) for detection of alpha or beta radiation (Manufacturer spec.)

C. Barometric Pressure/Altitude

- No observed effects

D. Humidity

- Up to 95%, non-condensing

E. Chemical Interference

- No observed effects

F. Radio Interference

- The DP6BD experienced no interference at frequencies in use at Rocky Flats
- The Electra Plus/DP8A should not be operated within 1m of any portable radio transmitter at Rocky Flats
- The Electra Plus/AP6 should not be operated within 1m of any portable radio transmitter at Rocky Flats

G. Gamma/Neutron Radiation Interference

- The DP6DB/DP8A will respond to gamma radiation fields, when monitoring for beta radiation move to an area with lower gamma levels if possible.
- The DP6DB/DP8A will respond to neutron radiation fields, when monitoring for alpha radiation move to an area with lower neutron levels if possible.
- The AP6 has not been evaluated for neutron interference.

IV. General Operations

A. Switch Configuration/Functions

- On/Off Button: Depress to turn instrument on or off.
- Rate/Integrate Mode Button: Depress to switch between the integrate and rate counting modes.
- Alpha/Beta Button: Depress to switch between alpha, beta, and alpha plus beta displays. [Not enabled for the AP6]
- Audible Loudspeaker Button: Depress to toggle the audible loudspeaker on and off
- Light Button: Depress to toggle the liquid crystal display light on and off.
- Set Up Button: distinguishes between settings which can be varied by the user and settings which are inhibited to the user but adjustable under supervision.
- Enter Button: Used for storage of display setting or display background.
- Ø Button: Depress to prevent adjustment of particular settings in use or on the Electra Plus allows access to the data logging functions

4h

- Increase/Decrease Buttons· Allows all settings (observed by pressing the "Set Up" button) to be adjusted up or down when the internal User/Supervisor switch is set to Supervisor On the Electra Plus, allows access to the Peak Hold mode functions.
- Internal User/Supervisor Switch When set to "Supervisor", allows settings to be adjusted by supervisor and locked in by depressing the "Ø" button and then switching back to the "User" position.
- Internal Show/Hide Switch When set to "Hide" all settings distinguished by the Ø symbol are hidden, in the "User" switch setting

B. Scan Rates

See Section II A

C. Scan Distance

See Section II A

D. Performance Test Requirements

Required to be performance tested daily and prior to use The instrument shall be performance tested by a qualified RCT Technician in accordance with approved Radiological Protection procedures Performance test requirements cover the following items.

- Instrument battery/power supply is satisfactory
- Instrument audio check is satisfactory, as applicable
- Instrument light leak check is satisfactory, as applicable
- Instrument background response check is within tolerances of expected values
- Instrument reading falls within ±20% of the reference performance test reading
- The sources used for instrument performance checks shall at least meet the minimum criteria specified below

	Nominal Value	Minimum Value
Alpha (Pu-239)	20,000 dpm	4,000 dpm
Beta (Sr/Y-90)	20,000 dpm	4,000 dpm

E. Operational Test Requirements

No additional operational test requirements beyond the performance test requirements

F. Good Practices/Precautionary Measures

- Be very, very careful not to puncture thin mylar coating on scintillation probes (0.5 mm)
- Do not drop or bang probe due to sensitive photomultiplier tubes
- Do not disconnect probe with power to instrument left on - turn power off first or instrument damage could occur

G Maintenance Allowed by User

Battery change out is allowed

VICTOREEN 450 B/G
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I Instrument Characteristics

A Physical Description

The Victoreen Model 450B is a hand-held, battery operated, microprocessor based, air ionization chamber instrument calibrated in exposure rate units of roentgens/hour It is designed to measure alpha radiation above 4 MeV, beta radiation above 100 KeV and gamma radiation and X-ray radiation above 7 KeV A 400 mg/cm^2 sliding Bakelite shield is provided as a beta shield This shield also serves as an equilibrium thickness for photon measurements and protects the mylar window The 450B contains a LCD digital readout and a 100 segment analog bargraph The unit is auto-ranging and auto-zeroing

The Model 450G is a hand-held, battery operated, ionization chamber designed to measure gamma radiation above 7 KeV It contains the same features as the 450B minus the beta window slide and has no beta detection capability

B Features

- 200 cc volume air ionization chamber
- Bakelite chamber wall is 200 mg/cm^2 thick
- Beta chamber window is 1 7 mg/cm^2 mylar
- Microprocessor based for data collection, averaging, multiplication by stored calibration factors, range changing, and battery check functions
- Digital and analog displays
- Auto-ranging and auto-zeroing
- Light contained in handle for display

C Scaler/Meter/Detector Configurations

Mode button allows configuration to either display exposure rate values or display integrated exposure

II. Instrument Specifications

A MDDR

1 mR/hr based on "ideal" counting statistics, background of 0 01 mR/hr, and optimal static source geometry (Actual field measurements and the variables therein will dramatically affect this value)

B Types of Radiation Measured

- Alpha above 4 MeV with model 450B (450G is not sensitive to alpha)
- Beta above 100 keV with model 450B (450G is not sensitive to beta)
- Gamma and X-ray lower energy threshold 7 keV with model 450B and at least 60 keV with model 450G

C Ranges

- 0-5 mR/hr
- 0-50 mR/hr
- 0-500 mR/hr
- 0-5 R/hr
- 0-50 R/hr

D. Energies

20 keV to 1 3 MeV (Energy ranges of concern at RFETS are 57 keV to 2 73 MeV for Cs-137, fission fragments, decay products of Pu, U, and Am isotopes)

E Efficiencies

Not applicable (non-quantifiable) for dose rate instruments

F. Types of Batteries and Life

- Two 9-volt transistor batteries (main power) & 2 AAA batteries (for backlight)
- Battery life is approx 200 hrs on continuous operation for the main batteries Each battery will operate the instrument for approx 100 hours and will run independent of each other allowing continuous operation during battery change
- LOW BAT message will appear on the display approx 1 5 hours prior to the instrument becoming inoperable

G Sensitivity

Not applicable to Ionization chamber type instruments

H. Audio

Audio alarm set points are set using a PC and the Model 450A-1 communicator

I. Linearity

Within ± 6% of reference readings

J Modes of Operation

- Can be configured so that MODE button alternately toggles display of exposure rate values and display of integrated exposure
- FREEZE Mode operation gives the operator a constant reference of the highest exposure rate obtained from the time the freeze function is initialized

K. Voltage Range

-90V collection voltage

L. Alarm Range

Audio alarm can be set in increments of 1% up to full scale (100%)

M Calibration Stability

Within ± 6% of reference readings

N Response Times

- 0-5 mR/hr = 9 3 seconds
- 0-50 mR/hr = 3 to 5 seconds
- 0-500 mR/hr = 2 to 2 3 seconds
- 0-5 R/hr = 1 5 to 2 5 seconds
- 0-50 R/hr = 1 to 2 5 seconds

O Calibration Limitations

A Model 450A-1 communicator (infrared signal) is used in conjunction with a PC for calibration of the instrument The survey meter will communicate via the Model 450A-1 communicator and send test signals/data to the PC Calibration adjustments can also be entered via the PC to the Model 450 B/G

III Limiting Conditions of Operation

A Temperature

Operating range of -4° F to 104° F (-20° C to 40° C)

B Barometric Pressure/Altitude

No testing done

C Humidity

- Effective for 0-98% relative humidity for Model 450G (non-condensing @ 60° C)
- Effective for 0-100% relative humidity for Model 450B (non-condensing @ 60° C)

D Chemical Interference

None known

E Radio Interference

No abnormalities noted when exposed to 140, 915, and 2450 MHz fields at 20 V/m Substantially reduced responses were noted when exposed to a frequency scan from 100 kHz to 1000 MHz at 20 V/m compared to the instruments response when the field was not present

Site radios may interfere, past experience has shown meter deflection

IV. General Operations

A Switch Configuration/Function

- Auto-on light automatically turns on when ambient light drops below a pre-determined level
- Overrange rate if the instantaneous dose rate exceeds 50 R/hr the "R" in mR/hr will blink
- Low battery indicator Approximately 1 5 hours of operation are remaining when the LOW BATTERY indicator blinks
- INTEGRATE Mode operational 30 seconds after instrument is turned on
- FREEZE Mode places a "tick" mark on the bargraph display to hold on the peak displayed value and lock on the maximum range

B Background Counting

Not applicable

C Scan Rates

Not applicable

D Scan Distance

Not applicable

E. Performance Test Requirements

- The Model 450B/G shall be performance tested as a minimum once every 24 hours during each operational use period
- The instrument shall be performance tested by a qualified HPI Technician in accordance with approved Radiological Protection procedures
- Performance check response shall be ± 20% of mean reference reading

F. Operational Test Requirements

- Ensure that calibration due date has not expired
- Verify that instrument has been Performance tested within the last 24 hours prior to use
- Verify battery power is satisfactory
- Ensure that the instrument is not damaged or otherwise impaired

G Good Practices

- On the Model 450B use caution to not damage mylar beta window

H Maintenance Allowed by User

- Batteries (located in handle) may be changed by instrument user
- All other maintenance shall be performed by qualified HPI personnel

BICRON FRISKTECH WITH A-100 (ALPHA) AND B-50 (BETA) PROBES INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description:

The Bicron Frisktech is an alarming ratemeter designed to use GM or scintillation detectors in a wide variety of "frisking" or monitoring applications Additionally it has an optional built in scaler and mR/h meter scale that add to its versatility The Frisktech is used with the Bicron A-100 probe which is a ZnS scintillation, 100 cm^2 alpha detector, and the B50 probe which is an organic scintillation, 50 cm^2 beta detector Both probes are designed to be used with the Frisktech ratemeter or scaler function

B. Features:

- Built in digital Scaler & recorder outputs
- Can be used with GM or scintillation detectors
- Regulated battery recharge
- Adjustable response times
- Audible/visual alarms (audible is adjustable)
- Can be used as a portable or stationary monitor
- High efficiency organic scintillation detector (B-50 probe)

C. Scaler/Meter/Detector Configurations

The Frisktech is used with the A-100, and the B-50 scintillation probes The A-100 probe has a 100 cm^2 sensitive area designed for alpha detection The B-50 probe has a 50 cm^2 sensitive area and is used for beta or alpha detection Both probes are used to provide scaler measurements Probes are calibrated to the specific Frisktech instrument and should not be interchanged

II. Instrument Specifications

A. MDA

A-100 Probe MDA for alpha (Pu-239)

- 1 minute count = 55 dpm/100 cm^2 with a stationary count in the scaler mode, Assuming a 17% probe efficiency, 0 25 inch surface to probe distance, and 2 cpm or less background
- 6 second count = 282 dpm/100 cm^2 with a stationary count in the scaler mode, Assuming 17% probe efficiency, 0 25 inch surface to probe distance, and 2 cpm background or less

B-50 Probe MDA for beta (U-238)

- 1 minute Count = 662 dpm/100 cm^2 with a stationary count in the scaler mode, Assuming a 26% probe efficiency ,0 5 inch surface to probe distance, and a 250 cpm background or less
- 6 second count = 2000 dpm/100 cm^2 with a stationary count in scaler mode, Assuming a 26% probe efficiency, 0 5 inch surface to probe distance, and 250 cpm background or less

B. Types of Radiation Measured

Alpha , beta, incidental gamma
(Note The B-50 probe has a gamma sensitivity of 3,600 cpm/mR/hr The A-100 probe has minimal gamma sensitivity in fields up to 1 R/h when appropriate HV settings are used)

C. Ranges

Standard. 0-500k cpm

D. Energies

- Alpha - A-100 Probe Typical 35% for Po-210 (5 3 MeV)
- Beta - B-50 Probe Typical 15% for C-14 (155 KeV) to 35% for Cl-36 (709 KeV)

E. Efficiencies

- A-100 probe 17-23% for Pu-239 , 50% for Th-230
- B-50 Probe 25-33% for Sr/Y-90

F. Types of Batteries and Life

- Dual 6 volt, rechargeable gelled cells
- >50 hours between charges, battery indicator indicates low battery
- < 10% change in reading through "bat.ok" check band
- Regulated battery recharge operates whenever unit is connected to AC power

G. Sensitivity: (Uniformity)

- A-100 + or - 10% over the probes surface
- B-50 . Within 10% for alphas & high energy betas within 25% for low energy betas

H Audio

- Provides an audible click for each detector pulse plus an audible alarm, or just an audible alarm alone.
- Adjustable when in the "pulse/alarm" mode, does not affect volume when the "alarm mode"
- Rate alarm is non-latching with front panel adjustment

I. Linearity

Within 5% of full scale within 10% of reading above 20% of full scale

J. Modes of Operation

- Rate Mode Response times are adjustable from 2 to 20 seconds Rate mode should be used for personnel self monitoring and contamination surveys
- Scaler Mode Uses 6 second or 1 minute count times ; used for counting smears, etc

K. Voltage Range

- Adjustable from 400 to 2000 V w/meter readout (factory set to 900 VDC)
- Maximum voltage is 1500 V
- 115 VAC but convertible to 210-250 VAC

L. Alarm Range

- From 10% to 130% of full scale and meter readout
- Red LED indicator on front panel

M. Calibration Stability

"As-found" values must be within 10% of the previous calibration reference value

N. Response Times

- Continuously adjustable from 2 to 20 seconds on all 4 count rate ranges
- The response control has no effect on the "alarm set" , "bat" or "HV" positions of the ratemeter control switch These response times for these modes are preset to be < 1 sec

O. Calibration Limitations

- Must be calibrated every 6 months by qualified HPI personnel
- Calibrated electronically using a variable frequency pulse generator

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III. Limiting Conditions of Operation

A. Temperature

- Frisktech meter/scaler Operational from -20 C to + 50 C
- A-100 Probe No limiting factors for use
- B-50 Probe -10 C to +30 C (14 to 86 F) and maximum of 50% relative humidity to stay within 20% of calibration reference values

B. Barometric Pressure/Altitude

No observed effects

C. Humidity

Limiting condition for B-50 probe is < 50% relative humidity to stay within 20% of calibration reference values

D Chemical Interference

No observed effects

E. Radio Interference

None observed at frequencies used at RFETS

IV. General Operations

A. Switch Configuration/Function

- Power on/off knob
- Reset alarm knob provides rapid meter zeroing When depressed the meter will remain at zero for all 4 count rate ranges , "HV", "alarm set" , and "bat"
- Ratemeter mode has 7 settings (Alarm set, Battery check, HV check, and x1 to x1000 scales)
- "Alarm Set" - alarm level is set from 10-130% of full scale via the alarm set potentiometer located immediately to the left of the control knob A small flat bladed screwdriver is required for adjustment
- "Bat " setting - the strength of the internal batteries is indicated on the meter
- Slow/fast response adjustment
- Audible alarm volume controls the internal speaker In the "pulse" position the speaker provides an audible "click" for each detector event.
- Speaker adjustment for off, pulse/alarm, & alarm
- Scaler count time, adjustable via 3 position switch on rear panel to 0 1, 1, and 10 minutes
- Recorder output is located on rear panel of unit to provide remote analog meter readout
- Scaler output is located on rear panel of the unit to provide logic type pulse for each detector event. The pulse width is approx 15 microseconds
- Headphone output is located on rear of unit and provides a pulse output for each event to headphones

B. Background Counting

Typically 6 second and 1 minute count times are used in scaler mode No background subtraction on count rate mode

C. Scan Rates

- Ratemeter Mode. A-100 (alpha) and B-50 Probes 2 inches/second @ 2 cpm bkgd or less for the A-100 and 250 cpm bkgd or less for the B-50 - probes to be within 1/4 inch surface to probe distance
- Scaler Mode 6 second or 1 minute stationary counts within ¼ inch of surface to probe distance

D. Scan Distance

- Within ¼ inch distance for scan mode
- Within ¼ inch for stationary count in scaler mode

E. Performance Test Requirements

Required to be performance tested daily prior to use The instrument shall be performance tested by qualified RCTs in accordance with approved Radiological Protection procedures Performance check reading shall ensure that the instrument reading is within 20% of performance check values

F. Operational Test Requirements

Operational Checks shall be performed prior to each use and shall include the following items

- Instrument battery power is satisfactory If low "bat" meter reading reconnect instrument into AC power to recharge the internal batteries
- Instrument audio check is satisfactory
- Instrument is not damaged or unsuitable for use
- Instrument calibration period is not expired
- Instrument has been performance checked within 24 hours

G Good Practices/Precautions

- Use caution to not puncture mylar over detector probe face
- Do not drop due to sensitive photomultiplier tubes
- Do not interchange probes, they are calibrated to a specific Frisktech meter
- The detector should always be stored with its protective cover in place to prevent window damage
- The power switch should always be turned "off" prior to connecting or disconnecting the detector cable
- When "bat" meter band reading is low and unit is disconnected from AC power it should be reconnected to the AC power to prevent full discharge of the internal rechargeable gel cell batteries

H Maintenance Allowed by User

Any required instrument maintenance (including battery replacement) shall be referred to HPI personnel

BICRON MICROREM METER
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A Physical Description:

The Harshaw-Bicron Micro-Rem/Micro-Sievert Meter is a light weight, portable survey instrument that utilizes a tissue-equivalent organic scintillator to directly read deep dose equivalent from gamma and X-ray at the 1 cm deep dose equivalent index The instrument gives tissue-equivalent photon response for gamma and X-ray radiation at energies from 40 keV to 1 3 MeV from environmental levels of 0-20 µRem/hr (0-0 2 µSv/hr) to survey levels of 200 mrem/hr (2 mSv/hr) A low energy response option allows the same detection ranges down to a photon energy of 17 keV

The instrument is a small hand held meter designed for direct monitoring of personnel deep dose equivalent without the necessity of conversion from mrad/hr

B. Features:

- Internal Tissue-equivalent scintillator
- Flat energy response
- HV Check
- Wide View meter
- Gamma and X-ray detection
- Five decade range
- Splash-proof, shock proof all metal case

C *Scaler/Meter/Detector Configurations.*

One internally mounted tissue-equivalent organic detector
Extended detector option is available and is mounted so that its sensitive area extends out from the front of the instrument case bottom, making it easier to survey certain hard-to-reach locations

II Instrument Specifications

A MDDR.

17 µrem/hr (using site guidance, assuming a background of 10 µrem/hr)

B Types of Radiation Measured

Gamma & X-ray

C Ranges.

- 0 - 20 µrem/hr
- 0 - 200 µrem/hr
- 0 - 2,000 µrem/hr
- 0 - 20,000 µrem/hr
- 0 - 200,000 µrem/hr

D Energies

40 keV to 1 3 MeV
Energy sensitive down to 17 keV with the Low Energy response option

E Efficiencies

Not Applicable

F Types of Batteries and Life·

- Two 9-volt batteries
- >100 hours battery life under normal use

G Sensitivity:

See "MDDR" above

H Audio.

No alarm capabilities

I Linearity

Within 10% of reading between 20% and 100% of full scale on any range

J. Modes of Operation

Single mode - dose rate meter surveys

K. Voltage Range.

HV is electronically stabilized with factory set HV during calibration with check band on the meter

L Alarm Range

No alarm capabilities

M Calibration Stability

Instrument response is within 10% for Cs-137 between 20% and 100% of full scale on any range
Dose equivalency is within 1% across the entire range of instrument energy

N Response Times·

Optimized for each range, 0-90% of final reading as follows

- x 0 1 = < 15 sec
- x1 = < 15 sec
- x 10 = < 5 sec
- x100 = < 2 sec
- x1000 = < 2 sec

O. Calibration Limitations

None known at present time

III Limiting Conditions of Operation

A Temperature:

- Operable from -4° F (-20° C) to 122° F (50° C)
- DO NOT USE BELOW - 4° F (-20° C)

B Barometric Pressure/Altitude·

No observed effects

C Humidity.

< 5% change in reading from 10-95% relative humidity

D. Chemical Interference

None known

E. Radio Interference

No test data available

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IV. General Operations

A. Switch Configuration/Function

- On/Off switch
- "bat" switch - provides meter band indication of battery strength
- "HV" switch - provides meter band indication of HV factory settings

B. Background Counting:

Not Applicable

C. Scan Rates

Not applicable

D Scan Distance.

Not applicable

E. Performance Test Requirements:

- HPI Technician performs Daily Performance check using an Am-241 source
- Performance check values must be within 20% of established reference values

F Operational Test Requirements

- Ensure that the instrument calibration due date has not expired
- Verify that the instrument has been Performance checked within the last 24 hours
- Verify battery power is satisfactory
- Verify that HV setting is satisfactory
- Ensure that the instrument is not damaged or otherwise impaired

G. Good Practices/Precautions

Use caution to prevent damage to the thin mylar window opening on the extended and low energy probe option

H Maintenance Allowed by User

Batteries can be changed by user

LUDLUM MODEL 2929 WITH MODEL 43-10-1 SAMPLE COUNTER
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A Physical Description

Dual Channel Scaler designed for use with "phoswich" and/or proportional detectors At RFETS the Model 2929 Scaler is used with a dual scintillation detector (model 43-10-1) composed of ZnS (for alpha detection) adhered to plastic scintillation material (for beta detection) A pulse height analyzer is employed to provide information to two independent counters The sample holder when fully closed activates a micro switch that allows HV to be applied to the Photomultiplier tube The sample drawer is locked in position by rotation of the slide lever mounted on the side of the instrument

B. Features

- Simultaneous alpha/beta counting
- Micro switch activated sample drawer w/lock to ensure constant reproducible counting geometry
- Magnetically shielded PMT
- Separate audio for alpha and beta channels
- Separate digital scaler readout windows for alpha and beta
- Two 15 PIN connectors to allow for recorder, printer, or software interface
- Adjustable count time periods from 0 1 - 990 minutes

C. Scaler/Meter/Detector Configurations

- Used with the M43-10-1 Alpha-Beta Sample Counter assembly consisting of sample drawer w/micro switch positioning and drawer lock, and a 2 25" diameter end window dual scintillation detector composed of ZnS (Ag) coated on a 0 01" thick plastic scintillation detector
- Detector window is 0 4 mg/cm^2 aluminized mylar

II. Instrument Specifications

A. Minimum Detectable Concentration (MDC)

- Alpha 18 dpm/100 cm^2 - based on 0 8 cpm background, and 33% efficiency
- Beta 205 dpm/100 cm^2 - based on 195 cpm background, and 25% efficiency
- Above MDC values are only valid for removable alpha/beta swipes

B. Types of Radiation Measured

Alpha, Beta

C. Ranges

0 - 999,999 counts on two separate LED displays

D. Energies

Adequate for all isotopes of concern at RFETS
See "Efficiencies" below for energy dependence

E. Efficiencies

- Alpha 37% Th-230, 39% U-238, 37% Pu-239
- Beta 8% C-14, 22% Tc-99, 29% Cs-137, 26% Sr-90/Y-90
- Above values are typical efficiencies from a range of efficiencies and are based on a 4 pi geometry

F Types of Batteries and Life

95-135 VAC (178-240 VAC available) 50-60 Hz single phase (less than 100 mA)

G Sensitivity

- Assume uniform sensitivity across 2.25" detector face
- < 10 % alpha cross talk in beta channel , <1% beta cross talk in alpha channel

H Audio

Built in unimorph type speakers with volume controls to provide a dual tone (1 per channel) click-per-event audio

I Linearity

Read outs within 2% of true value

J. Modes of Operation

Scaler mode as a swipe (smear) counter to measure removable alpha-beta surface contamination

K. Voltage Range

- HV is adjustable from 200-2500 volts
- Will support 60 megaohm scintillation loads

L. Alarm Range

No alarm capabilities (Not applicable to scalers)

M. Calibration Stability

Within 10% of previous calibration reference values

N. Response Times

Not applicable to scalers/swipe (smear) counters

O. Calibration Limitations

At RFETS the alpha efficiency is set to 33% using a Pu-239 source by adjusting HV settings (administrative setting) The Model 2929 is calibrated for use with a specific detector and cable Changing the detector or cable will invalidate the current calibration

III. Limiting Conditions of Operation

A. Temperature

- Acceptable operating range is -4°F to 85°F (-20°C to 25°C)
- Instrument will read >20% over calibration values at temperatures >85° F DO NOT USE ABOVE THIS TEMPERATURE

B Barometric Pressure/Altitude

No observed effects

C. Humidity

Acceptable in relative humidity of 95% (non-condensing) for up to 8 hours

D Chemical Interference

None known

E. Radio/Microwave Interference

- Tested and acceptable from frequencies of 0 3-35 MHz and 140 MHz at 50 volts/meter
- Tested and acceptable when exposed to 915 MHz and 2 45 GHz at 0 4 watts/meter^2 and 2 0 watts/meter^2

IV General Operations

A Switch Configuration/Function

- HV readout analog meter - displays HV settings continuously
- HV dial - 10 turn dial used to adjust detector HV
- On/Off switch - used to turn power on or off
- Minutes wheel dial - two digit thumb-wheel switch used to dial in the count time Used in conjunction with the Multiplier switch located to the right
- Count button - initiates a count cycle when depressed and will also reset both counters

- LED Lamp - indicates that a counting cycle is in progress
- Hold button - push button used to stop a count cycle The counters will hold the value present at the time this button is pressed
- Beta-Gamma Volume knob - rotary control used to vary audio output of the B-G channel
- Alpha Volume knob - rotary control used to vary audio output of the alpha channel
- Alpha Count LED Display - indicates counts received in the alpha channel
- Beta -Gamma Count LED Display - indicates counts received in the beta channel
- AMP OUT - a BNC connector providing access to amplifier
- ALPHA OUT - 15 PIN type "D" connector used as data output for the alpha channel
- BETA-GAMMA OUT - 15 PIN type "D" connector used as a data output for the beta-gamma channel

B. Background Counting

- Ambient background of 35 µR/hr = 60 cpm Beta-Gamma, 0 25 cpm Alpha
- Typical background of 1 cpm alpha and 200 cpm beta based on 1 minute count from averaged 10 minute background count
- 10 minute background counts for alpha and beta channels required by RFETS procedure

C. Scan Rates

Not applicable

D. Scan Distance

Not applicable

E. Performance Test Requirements

The Model 2929 shall be performance tested by an RCT prior to use each shift, and the average background count rate determined

F Operational Test Requirements

Prior to use each shift

- Verify the calibration due date on the calibration sticker has not expired
- Ensure that all required performance checks have been performed
- The 10 minute equipment initial warm up time has been met
- Verify the instrument is not damaged or otherwise impaired

G. Good Practices/Precautions

- Use caution to not contaminate the slide drawer when placing swipes (smears) into the counter Use of planchets or petri dishes are strongly recommended
- Do not tip sample counter over with sample holder in sample slide The sample holder will tear the thin mylar window creating a light leak and excessive counts
- Do not interchange sample counter assembly, detector, or cable They have been calibrated to a specific instrument and interchanging will invalidate the current calibration
- Only paper swipes (smears) and appropriate check sources should be placed in the sample holder Do not place any foreign objects into the sample holder as they may damage the detector

H. Maintenance Allowed by User

- User should clean sample holder as required using cotton swabs or Kimwipes® moistened with alcohol
- All other maintenance on the Model 2929 shall be performed by qualified HPI personnel

LUDLUM 12-4 WITH MODEL 42-31 NEUTRON DETECTOR
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I Instrument Characteristics

A Physical Description

The Ludlum Model 12-4 is a count ratemeter connected to the Ludlum Model 42-31 Neutron Rem Detector for the detection of neutron radiation The Model 42-31 Neutron Rem detector is a 9-inch diameter, cadmium loaded, polyethylene sphere with a BF_3 proportional detector tube in the center This detector measures the dose from neutrons over the energy range from 0 025 eV (thermal) to about 10 MeV

B Features

- Splash proof shields for outdoor use
- Removable detector
- Weighs 21 lbs
- Meter re-zero function

C Scaler/Meter/Detector Configurations

Used with the Model 42-31 Neutron Rem Detector only

II Instrument Specifications

A Minimum Detectable Dose Rate (MDDR)

The MDDR is 1 mrem/hr based on empirical data and testing Note This MDDR applies to model 12-4 meters with the 0-10 mrem/hr scale face plate

B Types of Radiation Measured

Neutron

C Ranges)

0-10 mrem/hr
0-100 mrem/hr
0-1,000 mrem/hr
0-10,000 mrem/hr

D Energies

Thermal (0 025 eV) to approximately 10 MeV

E Efficiencies

Approximately 30 cpm/mrem/hr (AmBe neutrons)
Approximately 20 cpm/mrem/hr (bare Cf neutrons)

F Types of Batteries and Life

- 2 "D" cell alkaline batteries
- Approximately 600 hr life

G Sensitivity

Adjustable from 2 to 60 millivolts

H Audio

- Built in unimorph speaker with ON/OFF switch
- > 60 dB at 2 feet

I Linearity

Reading within 10 % of true values

Reviewed For Classification/UCNI
By [signature]
Date 30 MAR 01

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J Modes of Operation

Dose Ratemeter for Neutron detection only

K Voltage Range

Adjustable from 200 - 2500 volts

L. Alarm Range

Not applicable

M Calibration Stability

Satisfactory to within 10% of calibration source values

N Response Times

- 90% of full scale can be reached in 22 seconds on "S", Slow setting, 4 seconds on "F" fast setting
- At < 50 mrem/hr max response time is 30 seconds
- At 50 mrem/hr to 1 rem/hr response time is 10 seconds
- At > 1 rem/hr response time is 5 seconds

O Calibration Limitations

- Calibration requires a pulser and voltmeter
- Approximate calibration time is 1 hour
- The 9" Rem ball is calibrated to Cf-252 neutron energies and will meet response requirements
- Calibrated every 6 months

III Limiting Conditions of Operation

A Temperature

5°F (-15° C) to 122°F (50° C)

B Barometric Pressure/Altitude

No discernible effects

C Humidity

- No noted effects but no testing completed
- O-ring seal on case to prevent moisture penetration

D Chemical Interference

None known

E Radio Interference

No testing data available

IV General Operations

A Switch Configuration/Function

- Speaker Switch has ON/OFF capability
- Meter Dial 0-10 mrem/hr scale selection, BAT TEST
- Response Switch toggle switch for "F", FAST (4 seconds) or "S", SLOW (22 seconds)
- Reset button push-button to re-zero meter reading

B Background Counting

Background will vary by location on-site

C Scan Rates

Not Applicable

D Scan Distance

Not Applicable

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LUDLUM 12-4 WITH MODEL 42-31 NEUTRON DETECTOR
INSTRUMENT TECHNICAL SPECIFICATION SHEET

E Performance Test Requirements

- Must be performance checked daily by an HPI Technician
- Performance check results must be within 20% of reference values

F Operational Test Requirements

- Verify that calibration due date has not expired
- Verify that a Performance check has been performed within the last 24 hours prior to use
- Inspect the instrument for physical damage or other impairments that would cause its inoperability
- Check battery power

G Good Practices/Precautions

- Use caution not to drop the instrument It is heavy and can cause physical injury and instrument damage
- When measuring general area readings at one-foot (30 cm), the unit should be positioned such that the CENTER (not the edge) of the rem ball is located at 30 centimeters or 12 inches from the source
- Response of these units can be highly variable dependent on the angle of the detector with respect to the source All measurements must be made with the detector at 90 degrees from the active area of the source For example, if the source is in the floor below or the overhead above, the rem ball must be rotated 90 degrees from the upright position in order to obtain an accurate measurement
- Only qualified HPI personnel are allowed to access instrument internals

H Maintenance Allowed by User

- Change out of batteries is allowed by user
- All other maintenance shall be performed by qualified HPI personnel

LUDLUM 2
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The Model 2 is a portable radiation survey instrument that is used in conjunction with the Ludlum Model 44-6 stainless steel wall G-M probe The Model 2 has 3 linear ranges from 0 to 50 mR/hr and operates on 2 "D" cell batteries The Model 44-6 detector is a Beta-gamma survey detector that incorporates a rotary shield, which when open allows for beta detection for energies > 200 keV The beta and gamma contribution can be determined by subtracting the reading with the closed shield from the open shield reading The dose range of the Model 44-5 is nominally linear (within 10%) up to 50 mR/hr without instrument dead time correction, and up to 500 mR/hr with dead time correction

B. Features

- Can operate with GM or Scintillation detectors
- 3 linear ranges
- HV is externally adjustable
- Audio ON/OFF switch
- External battery access
- Meter reset button

C Scaler/Meter/Detector Configurations

- Used at RFETS with the Ludlum Model 44-6 G-M stainless steel wall G-M probe
- Detector has a 30-45 mg/cm^2 stainless steel wall (halogen quenched)

II Instrument Specifications

A. MDDR

MDDR 0 4 mR/hr (using site guidance, assuming a background of 0 02 mR/hr)

B Types of Radiation Measured

Beta, Gamma

C Ranges

- 0-0 5 mR/hr
- 0-5 mR/hr
- 0-50 mR/hr

D. Energies

- Beta 200 keV - 3 27 MeV_{max}(based on the probe)
- Gamma 10 keV - 2 73 MeV

E Efficiencies

1,200 cpm/mR/hr for Cs^{137} gamma energy

F. Types of Batteries and Life

- two "D" cell batteries
- Typically 200 hr battery life

G Sensitivity

Input sensitivity of 30 mV (±10 mV)

H. Audio

Built in unimorph speaker with ON/OFF switch

I Linearity

Within 5% of full scale reading

J Modes of Operation

Portable radiation dose rate meter

K. Voltage Range

850-1000 Volts

L Alarm Range

No alarm functions

M *Calibration Stability*

- Less than 15% variance to battery end point
- Less than ± 6% variance from the mean reference readings over a period of 3 hours

N Response Times

4 seconds (± 1 second) on FAST setting , 22 seconds (± 4 seconds) on SLOW setting from 10% to 90% of final meter reading

O Calibration Limitations

- Calibration shall be performed every 6 months
- Calibration time is approx 2-3 hours
- Calibration is performed using a pulser, stopwatch, and voltmeter

III. Limiting Conditions of Operation

A Temperature

-67°F to 167°F (-55° C to 75°C)

B. Barometric Pressure/Altitude

Not tested but no noticeable effects

C Humidity

Testing not performed

D. Chemical Interference

No known effects

E Radio Interference

No testing performed

IV General Operations

A Switch Configuration/Function

- Range multiplier switch 5 position switch marked OFF, BAT, x10, x1, x0 1
- Audio ON/OFF switch
- FAST/SLOW toggle switch provides meter response from 4 seconds (FAST) to 22 seconds (SLOW)
- RES button when depressed re-zeros the meter reading

B. Background Counting

Not Applicable

C Scan Rates

Not applicable

D Scan Distance

Not applicable

E. Performance Test Requirements

- Must be performance checked daily when in use (by an HPI Technician)
- Performance check values must be within 20% of reference values

F. Operational Test Requirements

- Verify calibration due date has not expired
- Verify that the instrument has been performance checked prior to use (required daily)
- Check to see if battery power is satisfactory
- Inspect instrument for damage or other condition that could impair its performance

G Good Practices

- Do not interchange probes with other meters They are calibrated to a specific meter/probe configuration
- Only qualified HPI personnel are allowed access to instrument internals

H. Maintenance Allowed by User

- Batteries may be changed out by user
- All other maintenance shall be performed by qualified HPI personnel

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EBERLINE ESP-1
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The ESP-1 is a microcomputer based potable radiation survey instrument designed to operate with a variety of Eberline radiation detectors For neutron detection it is utilized with a Neutron Rem Detector (NRD) polyethylene ball The ESP-1/NRD combination reads out neutron dose rate from 0 001 to 60 Rem/hr and weighs 17 5 lbs The ESP-1 has 3 operating modes (Rate meter, Scaler, and Inquiry/Calibration) and has an LCD read-out which can read-out radiation units as selected and calibrated by the user The ESP-1 has an earphone output capability and internal speakers with audio alarm features

The NRD is a 9-inch diameter cadmium loaded polyethylene sphere with a BF_3 tube in the center This detector has been shown to have an energy response which closely follows the theoretical dose from neutrons over the energy range from 0 025 eV (thermal) to about 10 MeV. The BF_3 tube allows excellent gamma rejection and is identical to that of the Eberline PNR-4 portable neutron rem counter

B. Features

- Can be used with a variety of detectors
- Can be operated as count rate instrument or scaler
- Can be operated with cable lengths up to 100 feet
- LCD display with digital bar graph
- Excellent linear response with the NRD sphere due to programmable Dead Time corrections

C Scaler/Meter/Detector Configurations

- The ESP-1 can be operated in 3 modes , Rate meter, Scaler, or Inquiry/Calibration mode
- The ESP-1 is used at RFETs as a ratemeter attached to a neutron dose equivalent detector (NRD 9" ball)

II Instrument Specifications

A MDA

- 0 05 mR/hr (this is an "ideal" MDA based on a background of 0 mRem/hr and assuming a static source geometry - actual field measurements and the variables inherent therein will dramatically effect this value)
- RFETS neutron background activity is typically less than the instrument lower detection threshold of 1 mRem/hr (the instrument's minimum readout) and will usually result in a zero or "less than detectable" reading in normal survey conditions

B Types of Radiation Measured

Neutron (ESP-1 w/NRD)

C. Ranges

0 001 to 60 rem/hr for the NRD detector

D Energies

0 025 eV (thermal) to approximately 10 MeV

E. Efficiencies

Gamma rejection up to 500 R/hr (begins to fail at 50 R/hr) dependent on HV setting

REVIEWED FOR CLASSIFICATION/UCNI
By B. W. Hoffman
Date 1-30-01

F Types of Batteries and Life

- The ESP-1 uses six "C" cell batteries
- Carbon-zinc batteries last 250 hours during continuous use
- Alkaline batteries last approximately 300 hours during continuous operation
- Low battery alarm (first character blinking on display) signals at least 4 hours of operation remain before end of battery life

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- The ESP-1 will turn itself off after it has operated for 2 hours under the "low voltage" condition (first character blinking) The instrument can be turned on by the operator and will operate for another 2 hours after which it will turn itself off again
- Internal capacitor allows battery change (within 20 minutes) without memory loss

G. Sensitivity

Approximately 50 cpm/mrem/hr (3000 counts/mrem)

H Audio

- 2000 Hz audio tone from the internal speaker
- The speaker/alarm provides an audible "click rate" which is proportional to the output of the amplifier/discriminator This rate can be scaled down when the high count rate detectors are employed

I. Linearity

Within 10% of mean reference reading

J. Modes of Operation

The ESP-1 w/NRD combination is used in the Rate Meter mode and calibrated to read out in mrem/hr

K. Voltage Range

- Low voltage 5 Vdc
- High Voltage (detector bias voltage) 350 to 2300 Vdc NRD operating voltage is typically 1600 to 2000 V

L. Alarm Range

Programmable from the Inquiry/Calibration Mode to alarm at values from 1 mrem/hr to 60 Rem/hr

M Calibration Stability

Within 10% of mean reference values on all scales

N. Response Times

No testing performed

O. Calibration Limitations

- Separate calibration constants must be entered via the Inquiry/Calibration Mode for each type of detector used with the ESP-1 Failure to enter the correct parameters for the NRD sphere may result in erroneous display values on the ESP-1 read-out
- A specific dead time (DT) must also be set for each type of detector used with the ESP-1 and each NRD sphere is calibrated to a specific ESP-1
- Pulse generator calibration is recommended

III. Limiting Conditions of Operation

A. Temperature

-4°F to 122° F (-20° C to 50° C)

B. Barometric Pressure/Altitude

No known detrimental effects

C. Humidity

Within 15% of mean reference values at 40% to 95% relative humidity (non-condensing) No testing performed at <40% relative humidity

D Chemical Interference

No testing done, but no detrimental effects expected

E. Radio Interference

No testing performed

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EBERLINE ESP-1
INSTRUMENT TECHNICAL SPECIFICATION SHEET

IV General Operations

A. Switch Configuration/Function

- The ESP-1 has a 7 push button array located on the instrument face
- ON/OFF Powers the instrument on and off A 1 minute warm up time is recommended prior to use
- MODE Used to enter one of 3 operating modes - Ratemeter, Scaler, or Inquiry/Calibration Modes
- RESET The functions of this switch depend on the operating mode selected for the instrument. In the Rate Meter Mode the RESET is used to maintain the bar graph In the Scaler Mode the switch resets the ESP-1 to a new count interval In the Inquiry/Calibration Mode the RESET switch allows the user to select or change parameters and when used with the "+" or "-" keys will increase or decrease the value set for that parameter
- LIGHT When pressed the display is illuminated
- "+" & "-" keys Use is dependent on the operating mode selected but generally used to increase or decrease parameters
- SPKR Pressing the switch turns the speaker on and off It also turns the alarm off when it activates When SPKR is used to silence the alarm the speaker remains on until the operator presses SPKR again

B. Background Counting

Not applicable when used with the NRD sphere

C Scan Rates

Not applicable when used with the NRD sphere

D Scan Distance

Not applicable when used with the NRD sphere

E. Performance Test Requirements

Daily during use (by an HPI Technician)

F. Operational Test Requirements

- Verify that calibration due date has not expired
- Verify that instrument has been performance checked daily during use
- Check LIGHT and SPKR switches to ensure the light and alarm/ratemeter speaker are working
- Inspect the instrument for damage or other impairments to its operation

G Good Practices

- The NRD sphere is relatively heavy -use caution not to drop it to prevent damage or personal injury
- The NRD is calibrated to a specific ESP-1 and should not be interchanged with other ESP-1s
- When measuring general area readings at one-foot (30 cm), the unit should be positioned such that the CENTER (not the edge) of the rem ball is located at 30 centimeters or 12 inches from the source
- Response of these units can be highly variable dependent on the angle of the detector with respect to the source All measurements must be made with the detector at 90 degrees from the active area of the source For example, if the source is in the floor below or the overhead above, the rem ball must be rotated 90 degrees from the upright position in order to obtain an accurate measurement

H Maintenance Allowed by User

All maintenance including battery change out shall be performed by qualified HPI personnel

EBERLINE XETEX TELESCAN 330A
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I Instrument Characteristics

A Physical Description.

The Xetex Telescan 330A is a portable gamma radiation survey instrument designed to measure gamma radiation levels from 0 35 mrem/hr to 1,000 rem/hr The instrument is microcomputer based and reads out on an analog meter The telescoping probe can be extended to approximately 13 feet This allows the measurement of high level radiation sources while the user maintains distance and reduces exposure It also allows measurements in hard to reach places The Telescan has two energy compensated G-M tubes in a remote head and have different sensitivities to cover a broad range of gamma radiation measurements Data from the remote head is transmitted to the base unit via infrared signal inside the hollow telescoping wand to eliminate the problems associated with wiring within the sliding telescope

B. Features

- High range and low range energy compensated detectors
- Optional plastic sheaths available for making underwater measurements
- Microprocessor based
- Carrying strap and carrying case provided to transport instrument
- Telescoping probe to 13 feet

C. Scaler/Meter/Detector Configurations

For use as a high range detector with an extendible probe to reduce personnel exposure and to monitor hard to reach areas

II. Instrument Specifications

A. MDDR

0 35 mR/hr on Low range detector (based on site guidance, using a background of 0 02 mR/hr)

B Types of Radiation Measured

Gamma, X-ray

C Ranges

- x100 = high range 0 - 1,000 R/hr
- x10 = high range 0 - 100 R/hr
- x1 = high range 0 - 10 R/hr
- x100 = low range 0 - 1,000 mR/hr
- x10 = low range 0 - 100 mR/hr
- x1 = low range 0 - 10 mR/hr
- x0 1 = low range 0 - 1 mR/hr

See **CAUTION** statement on Page 3

D Energies

70 keV to about 1 3 MeV (± 15%)

E Efficiencies

Not applicable

F. Types of Batteries and Life

- Four alkaline "C" cell batteries in the base unit (approx 400 hours life)
- Two 3 6 Volt lithium AA batteries in the remote probe (approx 350 hours life normal operation- 80 hours when in a 100 Rem/hr field)

G. Sensitivity

- High range probe 21 cpm/mR/hr
- Low range probe 1040 cpm/mR/hr

H. Audio

Internal speaker puts out 70 dB at 30 cm

I Linearity

10 % of reading (calibrated to Cs^{137})

J. Modes of Operation

- High range scale (0-1,000 R/hr)
- Low range scale (0-1,000 mR/hr)
- Can be used for monitoring high radiation areas without excessive personnel exposure
- With optional sheathing, can be used to take underwater measurements

K. Voltage Range

Operating voltage is 525 VDC for both detectors

L. Alarm Range

No alarm capabilities

M Calibration Stability

<10% variance over the calibration reference values

N. Response Times

Varies from 1 second to a maximum of 4 seconds depending on range and response pot setting

O Calibration Limitations

- Requires approximately 6-8 hours to calibrate
- High level gamma source required to calibrate highest scale ranges

II Limiting Conditions of Operation

A Temperature

0° C to 40° C (32° F to 104° F) ± 10%

B Barometric Pressure/Altitude

No detrimental effects

C. Humidity

Operable within 0-95% relative non-condensing humidity

D. Chemical Interference

None known

E Radio Interference

Results acceptable for both ranges tested during frequency scan (0 3 to 35 Mhz) and 140 Mhz at 50 volts/meter

IV. General Operations

A Switch Configuration/Function

- Analog meter - Scale from 0-10 with 10 divisions and 50 subdivisions
- Light - membrane push button ON/OFF
- Speaker - membrane push button - ON/OFF
- Reset - Push button resets meter reading to zero
- 9 position rotary switch - OFF, BATTERY, 7 decade scale
- LED light on base unit lights to indicate any of several failures in the remote detector and base unit The number of "beeps" corresponds to the meter reading for a particular malfunction as follows, (1= remote probe battery low, 2 = remote probe voltage low, 3 = infrared communications failure, 5 = over range on highest low range, and 8 = over range on highest high range)

B. Background Counting

Not Applicable

C. Scan Rates

Not Applicable

D Scan Distance

Not Applicable

E Performance Test Requirements

- The Telescan shall be performance checked at least every 24 hours when in use by an HPI Technician
- Performance check results shall be within 10% of reference values

F. Operational Test Requirements

Prior to use

- Verify that battery power is satisfactory
- Verify that instrument has been performance checked within the last 24 hours of use
- Verify that calibration due date has not expired
- Check LED failure light in detector base for failure indication
- Inspect instrument for damage or other impairment to its operation

G Good Practices

- Do not immerse probe in water without plastic sheath - it is not watertight
- Use caution in handling probe to ensure that the end detector or telescoped sheath is not damaged

H Maintenance Allowed by User

- User may change batteries in the base unit only by removing the handle and replacing the four "C" cell batteries
- All other maintenance shall be performed by qualified HPI personnel

CAUTION:

The instrument will not indicate overrange readings if it is turned on with its detectors in a high intensity overranging radiation field The detector must be brought into the overranging field after it is turned on in order for the latching overranging condition to be set Exposure rate saturation is < twice maximum scale reading (Saturation = 1300 R/hr for high range)

EBERLINE SWENDI (also WENDI-2)
INSTRUMENT TECHNICAL SPECIFICATION SHEET

I Instrument Characteristics

A Physical Description

Portable high-sensitivity neutron dose equivalent meter equipped with an Eberline E600 rate meter/scaler The WENDI-2 detector is 9" diameter, 12 1/2" high (including handle), and weighs approximately 30 lb The E-600 is 9" long, 4 1" inches wide and 6" tall It weighs 3 4 lbs

B Features

- Measures neutron dose equivalent and dose equivalent rate
- Automatic background subtraction feature available
- Dose equivalent rates as low as 15 to 100 microrem/hour are readable in the rate meter mode
- Large backlit display
- Autoranging display
- WENDI-2 stores its calibration parameters and can be used with any E600, not just the one initially used in calibration

C Scaler/Meter/Detector Configurations

E-600 meter and the WENDI-2 detector are connected by a coaxial cable and operated as a single unit Detector includes a helium-3 tube surrounded by a moderator designed to produce an approximately tissue equivalent dose response

II. Instrument Specifications

A Minimum Detectable Dose Equivalent Rate

15 microrem per hour in the rate meter mode (Based on slow response setting equal to 60 seconds and linear extrapolation of the signal below cardinal points of calibration)

B Types of Radiation Measured

Neutron

C Ranges

Autoranging from nanorem per hour to rem per hour

D Energies

Emulates a tissue equivalent response over the neutron energy range including thermal to 1000 MeV The response function is based on a theoretical calculation Overresponse of up to 40% is known to occur when a highly moderated (low energy) neutron spectrum is measured Under most conditions at RFETS the response is expected to be within 30% of the conventionally true value and corrections are not normally required for field measurements

E Types of Batteries and Life

Powered by three alkaline "C" cells Typical alkaline battery life 8 hours Use of the instrument may be continued until the unit disables itself due to low power

F Sensitivity

Nominally 600 cpm per mrem per hour

G Audio

User selectable

H Linearity

Within ± 5% of the conventionally true value for unmoderated californium-252 neutrons over the dose equivalent range of 2 5 to 4000 mrem per hour Definitive testing is not available at lower dose equivalent rates, but linearity is expected to be similar down to the limits of detection

I Modes of Operation

Normally used in the rate meter mode

Reviewed For Classification/UCNI
By [signature]
Date 20 MAR 01 (UCNI)

J Alarm Range

No alarm capabilities are enabled in this application

K. Calibration Stability

Not available

L Response Times

The time to reach 90% of the full scale reading varies depending on the position of the response switch

Fast	7 seconds
Medium	25 seconds
Slow	60 seconds

Use the slow response setting when accurate measurements are required and the dose equivalent rate is less than 0 1 mrem per hour

M Calibration Limitations

WENDI-2 and E600 are calibrated as one unit every six months or after maintenance and/or repair

N Angular Response

Depending on the orientation of the source to the detector the instrument can underrespond to high energy neutrons by 10% or overrespond by up to 15% For lower energy neutrons the overresponse can be larger See the Technical Basis Document 00136 for details Corrections are not normally required for field measurements

N Miscellaneous

Contains non-toxic, highly dispersible, powdered tungsten metal inside the polyethylene moderator Do not remove fasteners holding the polyethylene moderator together

III. Limiting Conditions of Operation

A Temperature

-4°F to 122°F (-20°C to 50°C)

B Barometric Pressure/Altitude

Insensitive to barometric pressure changes

C Humidity

Zero to 95% relative humidity, non-condensing

D Chemical Interference

None

E Radio Interference

Do not use within 1 meter of a radio transmitter

IV General Operations

A Switch Configuration/Function

Rotary switch functions

- Off
- Check
- Ratemeter
- Integrate
- Scaler
- Peak Hold (functions like Ratemeter, trapping the highest reading)
- Background (press star key to lock in background measurement after desired precision is attained)

Gross/Net button

User selectable with status displayed on screen If net is selected the value locked in using the star key in Background mode is subtracted from all measurements

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Speaker button
User selectable

Range
User selectable, but autoranging normally eliminates the need for this

Chnl
Handle-mounted button switches display units if enabled

Star key
Handle-mounted button has different uses depending on rotary switch position

Ratemeter	First press provides instantaneous readout, bypassing normal time constant calculations
	Second press returns to normal rate meter mode
Integrate	Provides a view of the rate meter mode as long as the key is pressed Does not interfere with integrated count
Scaler	Initiates a pre-set timed count cycle The count time is typically set for 6 minutes, but may be different
Peak-Hold	Releases the peak hold to begin again

Log
Handle-mounted button is pressed once to log sequential ID number, and again to record the displayed data

Light
Handle-mounted button momentarily illuminates the screen when pressed

B Scan Rates

Limited by response times referenced in II L

C Performance Test Requirements

Check for proper meter response against a known source All other tests are automatically performed when the instrument is turned on

D Operational Test Requirements

Performed daily by Health Physics Instrumentation Instrument locks itself out of service when calibration of either component is expired

E Good Practices

- Ensure proper response time is allowed, especially when making dose equivalent rate measurements where the reading is less than 0 5 mrem per hour
- When measuring general area readings at one-foot (30 cm), the unit should be positioned such that the CENTER (not the edge) of the cylinder is located at 30 centimeters or 12 inches from the source
- Response of these units can be highly variable dependent on the angle of the detector with respect to the source All measurements must be made with the detector at 90 degrees from the active area of the source For example, if the source is in the floor below or the overhead above, the cylinder must be rotated 90 degrees from the upright position in order to obtain an accurate measurement
- Be aware that the dose rate is measured at the centerline – not at the surface - of the detector Therefore a contact reading represents the dose equivalent 4 ½ inches from the surface being measured
- Use with a hand truck whenever possible to avoid carrying or lifting this heavy detector

F Maintenance Allowed by User

User is allowed to perform battery replacement only

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RadElec® ELECTRET ION CHAMBER
INSTRUMENT TECHNICAL SPECIFICATION SHEET

Instrument Characteristics

A. Physical Description

The electret ion chamber is a passive integrating ionization chamber It consists of a very stable electret (a charged Teflon disk) mounted inside a small chamber made of electrically conducting plastic The electret serves as both a source of the electrostatic field and a sensor The ions produced inside the chamber are collected only on the electret, causing a reduction of its surface charge The reduction in charge is a function of the total ionization during a specific monitoring period and the specific chamber volume The change in voltage is measured using Rad Elec's portable Electret Reader

B. Features

Integrated measurement for surface alpha contamination
Configured for SCO levels
Disposable components
Electrets discarded after voltage is discharged
Low volume high-range ion chamber
Portable battery powered voltage reader with digital display

C. Scaler/Meter/Detector Configurations

The LT-5 0 electret, 10-cm^2 ion chamber, and the Electret reader

II. Instrument Specifications

A. MDC

System is based on charge integration and an MDC is not defined A minimum voltage drop of 30 V is required to obtain acceptable uncertainty in the measurement

B Types of Radiation Measured

Alpha (Negligible response to beta, gamma and neutron.)

C. Ranges

The range is a function of the exposure time and the contamination level Optimized for SCO measurements
24-hour exposure detects approximately 28,000 dpm/100 cm^2
1 5-min exposure detects approximately 500,000,000 dpm/100 cm^2

D. Energies

Alpha. evaluated for clean surface emission for any alpha emitter found at RFETS
Beta not applicable for Pu contamination measurements

E. Efficiencies

Not separately defined for this instrument Correction factors incorporate efficiency and other factors

E. Types of Batteries and Life

Electret Reader One 9-Volt battery with a typical life of greater than 1 year

G. Sensitivity

30 Volts minimum voltage drop, greater than 230 V initial voltage, and exposure time of 1 minute or longer

H Audio

None

I. Linearity

The electret has a linear response up to 510-million dpm/100 cm^2

J. Modes of Operation

Manually timed integrated alpha exposures

K. Voltage Range

Typical initial voltage for a new electret is 700 volts and the operating range for final voltage is 200 volts minimum

L. Alarm Range

No alarm function

M. Calibration Stability

The individual electrets are calibrated by the manufacturer and selected by tolerance Batch testing is performed at RFE and the electrets are accepted if the samples are within ±20% of the conventionally true value

N. Response Times

The response time is the integration time required to cause a voltage drop of 30 volts

O Calibration Limitations

The Electrets are calibrated by the manufacturer The Electret reader is not calibrated, but is checked for proper operation before use by using reference electrets The readings with these reference electrets must be within 2 volts of their designated voltage

III. Limiting Conditions of Operation

A. Temperature

The electret can be exposed at any temperature but must be read after exposure at a temperature within 5 degrees of the initial voltage reading

B. Barometric Pressure/Altitude

No significant variation in the response of the electrets is expected at RFETS

C. Humidity

Erratic reading may occur at high humidity if the reader is not kept sealed in its case when not being used There is desiccating material in the case that keeps the reader dry No humidity effect on the electrets has been reported.

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D Chemical Interference

Unknown

E Radio Interference

The reader may be sensitive to a portable walkie talkie radio if transmitting within 15 cm of the reader at the time of reading the electret. Do not operate walkie talkie radio transmitters within 15 cm of the Electret reader when measuring electret voltages

F. Gamma Radiation Interference

The gamma response of the electrets is negligible with respect to the alpha exposure

IV. General Operations

A. Switch Configuration/Function

A mechanically activated shutter for the Electret reader to read the electret voltage.

B Scan Rates

N/A

C. Scan Distance

N/A

D Performance Test Requirements

The reader must be tested using the reference electrets each shift when in use or when a malfunction is suspected

E. Operational Test Requirements

Observe the Electret reader display for low battery indication.

F. Good Practices/Precautionary Measures

Do not touch the active surface of the electrets. Touching the active surface of the electrets will cause erratic results, however, no shock hazard is present Touching the electrets may reduce the electrostatic charge and change the surface discharge characteristics

Keep the electret and the chamber assembled prior to use

Keep the chambers and electrets clean and free of dust.

G. Maintenance Allowed by User

Battery change out on the Electret reader is allowed

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LUDLUM HIGH RANGE ALPHA ION CHAMBER, MODEL 195 READOUT WITH MODEL 43-132 ION CHAMBER PROBE INSTRUMENT TECHNICAL SPECIFICATION SHEET

I. Instrument Characteristics

A. Physical Description

The instrument consists of a lightweight (2 7 lb), portable, battery-powered readout unit with a lightweight (1 lb) hand probe The probe is a 100 cm^2 air filled ion chamber with a 0 4 mg/cm^2 Mylar window for alpha detection The readout and probe are collectively known as the Ludlum Model 195 The nickname is "SCOOBY TWO "

B. Features

The instrument reads out directly in units of million dpm, and because the probe measures per 100 cm^2 area, the readout is actually in million dpm per 100 cm^2 The hand probe is equipped with feet on each corner to provide a 1/8-inch spacing between the probe face and the surface being measured This reduces variability in measurements and minimizes contamination of the probe Field replacement of the probe can be performed by the RCT

C. Scaler/Meter/Detector Configurations

The meter is a direct digital readout The only configuration option available is cable length The cable can be connected to other Ludlum Model 195 cables to alter cable length in 3, 7, or 10-foot increments up to 20 ft in length

II. Instrument Specifications

A MDA

MDA as defined in RSP 02 01 is not applicable to this instrument However we define a lower limit of detection, which is a similar concept, as the lowest number that can be displayed on the readout The lower limit of detection is 0 01 million dpm per 100 cm^2, which is the same as 10,000 dpm per 100 cm^2 Put this number in the MDA field when writing survey reports

B. Maximum Operating Range

The upper limit for this instrument is 1000-million dpm per 100 cm^2 Readings in excess of this value have not been qualified and may or may not be accurate Readings in excess of this value should not be used as quality assured data for record purposes, however, they may be useful as unofficial indicators of contamination level

C. Types of Radiation Measured

This instrument is specifically designed to measure alpha surface contamination, but it is also sensitive to beta, gamma and neutron radiation Testing has shown that dose equivalent rates as high as 100 mrem per hour produce no significant reading

D. Ranges

- Low range spans from 0 01 to 20 00-million dpm per 100 cm^2 When a reading is off scale on the low range, the display shows the number "1" on the left hand side of the display The normal display - of 4 digits including a decimal point - is not seen
- High range spans from 1 to 1000-million dpm per 100 cm^2 Numbers in excess of this may be displayed, and may or may not be accurate, but they should not be recorded on survey report

RSP 09 05 Rev 3, Section 5 states *"Specialized instrumentation may be used over the full-specified range in the implementing procedure "* This instrument is specialized instrumentation, and it may be used to the full extent of its qualification for any purpose, including SCO characterization The 80% limitation does not apply to this instrument

E. Energies

- All alpha energies are detected

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F. Efficiencies

- Not applicable for this detector

G Types of Batteries and Life

- The Ludlum Model 195 uses two alkaline D-cell batteries Batteries may be changed in the field by the RCT No recalibration is required after battery change

H. Sensitivity

- Not applicable for this detector

I. Audio

- None

J Linearity

Response linearity to ±1% over the entire operating range of 0 01 to 1000-million dpm per 100 cm^2 has been demonstrated under laboratory conditions using NIST traceable sources and radiation fields

K. Modes of Operation

- Operates only in the rate meter mode with a direct readout of million dpm per 100 cm^2

L. Voltage Range

- The ion chamber operates at 85 V and produces an output signal of 0 to 5 V

M. Alarm Range

- No alarm capability

N. Calibration Stability

- No data have been accumulated to define this value Calibration of the readout unit at six-month intervals is planned Every probe is acceptance tested and calibrated upon receipt Probes are expected to be irretrievably contaminated during use, consequently "as found" testing of the probe at the end of the calibration cycle is unlikely to occur Performance testing is required prior to use and, if possible, at the end of service

O. Response Times

- Response time is 90% of the final reading within approximately 5 seconds

P. Calibration Limitations

- None
- The readout unit calibration due date is stated on the readout unit
- The probe calibration lasts indefinitely, as long as the performance test criteria (see section IV F) are met

III. Limiting Conditions of Operation

A. Temperature

- Qualified for use over the temperature range of 32° F and 120° F
- Use outside this temperature range is possible, but special calibrations are required

B. Barometric Pressure/Altitude

- Not affected by barometric changes associated with changes in the weather or changes in altitude that can occur at RFETS
- This instrument is calibrated for use at RFETS If the instrument is operated at altitudes that are different from the RFETS altitude by more than 500 feet, significant measurement bias may exist

C Humidity

- Not affected by ordinary changes in humidity
- Not designed for continuous use in areas where relative humidity is 100%

D Chemical Interference

- No data available

E. Radio Interference

- Affected by hand-held radio transceiver transmissions within 10 feet of the instrument The effect is transient and is usually obvious
- No effect from fluorescent lighting has been observed

F. Mylar Window Damage

- There is no significant effect on instrument readings if limited mylar window damage occurs The probe can remain in service as long as the hole in the mylar is not larger than ½-inch diameter or an equivalent area (for example two ¼ inch holes would also be acceptable) Any change in instrument response due to damaged mylar is conservative, which means the damage has the effect of overestimating the true contamination level For example, a ½-inch hole in the mylar produced a 3% over response in laboratory testing
- The instrument is not affected at all by light leaks that occur when mylar is damaged

G Shock and Vibration

- Shock and vibration do not have a significant effect on instrument readings Any effect is transient and is usually obvious

IV. General Operations

A Warm-Up Period

- After the instrument is turned on or the batteries are replaced, allow the detector to warm up for 5 minutes before taking data for survey reports This allows the ion chamber wall voltage to stabilize
- Operational and performance tests can be done during the warm up period If these test fail repeat them after the warm up period is complete

B. Switch Configuration/Function

- The range selector switch can be set at OFF, BAT, HI and LO
- A zero adjust knob, called the NUL, can be operated by the user when a probe change occurs The NUL is protected to prevent inadvertent adjustment
- Use of the NUL adjustment is limited to probe replacement Do not use the NUL adjust to remove a persistent background signal

C. Scan Rates

- Not applicable

D. Scan Distance

- Fixed at 1/8-inch above the surface by feet on each corner of the probe face

E. Background Subtraction

- As the probe gets contaminated, or in the unlikely event that beta, gamma or neutron radiation produces an interfering signal, a background reading will appear on the detector readout In that case the background reading is recorded and subtracted from the gross reading to result in the net contamination level

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LUDLUM HIGH RANGE ALPHA ION CHAMBER, MODEL 195 READOUT WITH MODEL 43-132 ION CHAMBER PROBE INSTRUMENT TECHNICAL SPECIFICATION SHEET

F. Performance Test Requirements

Performance tests are required

- Daily, prior to use, when the instrument is in service
- Daily, at the end of use
- Prior to probe replacement if practical, and
- Immediately following probe replacement

Performance testing can be performed using the built-in test feature on the Model 43-132 Ion Chamber probe with results documented with the survey

a) Battery Test
   - Test battery by putting the range selector switch on BAT
   - Replace if the green battery light does not illuminate

b) Electronic Test
   - Position the Model 43-132 Ion Chamber probe so it is not affected by a contaminated surface
   - Turn the range selector switch to HI
   - Note the expected increase during performance testing as shown on the calibration sticker
   - Note the displayed reading, which is the background
   - Press and hold the performance test button on the Model 43-132 probe
   - Note the displayed reading after the readout has stabilized This may take up to 10 seconds
   - Release the test button

The instrument passes the performance test if the displayed reading has been increased by an amount within the acceptable range (The acceptable increase range is the expected increase, plus or minus 15%)

Figure 1 and 2 are typical examples of the calibration sticker and calculation data

	RFP CALIBRATION			
S E P	CAL DATE	06/01/02	SERIAL NO	PR161523
	DUE DATE	NONE	SOURCE	Test button
	BY	21	TOLERANCE	234 -316

Figure 1, Typical Calibration Sticker

Example Parameter	**Example Result,** *Million dpm / 100 cm²*
Currently observed background	150
Expected increase when test button is pushed	275
Minimum increase when test button is pushed (- 15%)	234
Maximum increase when test button is pushed (+ 15%)	316
Minimum acceptable reading when test button is pushed (background plus minimum increase)	150 + 234 = 384
Maximum acceptable reading when test button is pushed (background plus minimum increase)	150 + 316 = 466

Figure 2, Example Parameter and Results Calculations

LUDLUM HIGH RANGE ALPHA ION CHAMBER, MODEL 195 READOUT WITH MODEL 43-132 ION CHAMBER PROBE INSTRUMENT TECHNICAL SPECIFICATION SHEET

G. Operational Test Requirements

- Perform operational tests every hour when the instrument is in service or prior to intermittent use

a) Operational Tests
   - Battery
   - Readings fluctuate as expected
   - Depress electronic test button and observe significant increase in displayed contamination level (It is not necessary to perform the calculations to demonstrate that performance test has been passed during hourly operational testing)

H. Good Practices

- Do not unnecessarily allow contact between the face of the probe and highly contaminated surfaces
- Note the location of a convenient area, called a field reference point, where the contamination level is significantly elevated
- Periodically during the survey, return to the field reference point to confirm the instrument reading is consistent with prior measurements If the instrument reading is not consistent with prior measurements, perform an operational or a performance test

I. Maintenance Allowed by User

Battery change and probe change is allowed

a) Battery Change

The battery should be changed when the battery indication light fails to illuminate when the BAT position is selected

- Open the battery compartment lid by twisting the opening the thumbscrew counterclockwise
- Remove the batteries and discard in an appropriate waste container
- Replace the batteries with two new alkaline D-cell batteries Observe the polarity requirements shown on the battery compartment
- Perform the battery test
- Allow 5 minutes for the chamber voltage to stabilize before recording data
- *Operational and performance tests may be performed during the warm up period*

b) Probe Change

The probe should be changed when 1) contamination of the probe reaches levels that interfere with measurements 2) the mylar is extensively damaged, or 3) other operational conditions indicate a *change would be beneficial*

Perform these actions only with a new, unused replacement probe
- Disconnect the old probe
- Place the new probe in a location and/or orientation where the expected reading is zero
- Connect the new probe
- *Select the LO Range readout*
- Adjust the NUL knob until the displayed reading is 0 00
- Conduct operational and performance tests

J. Cable Length

- Cables that connect the Model 195 and the Model 43-132 Ion Chamber probe can be assembled in any length or combination of lengths up to 20 feet
- Longer cables lengths can be used if a special calibration is obtained